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AUGUST, 1933

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Engineering and Mining Journal

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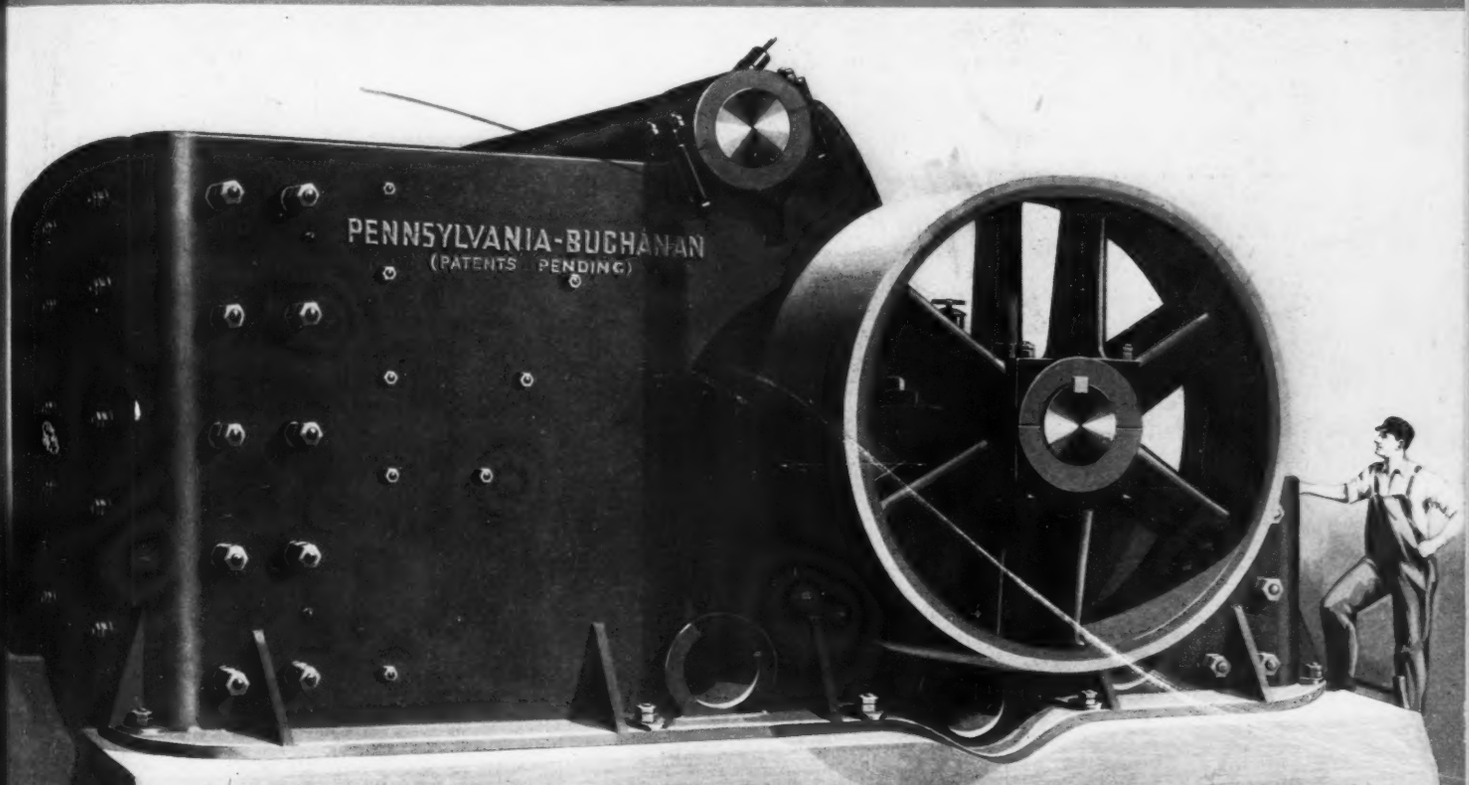

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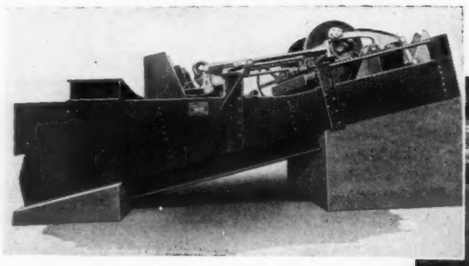
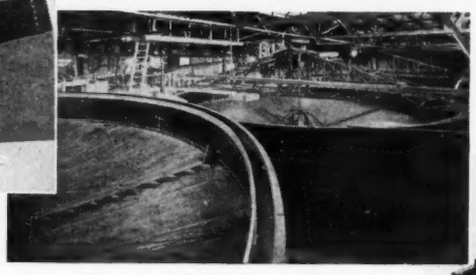
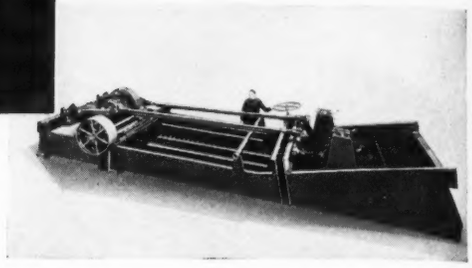


Above — Braden Copper Company's Dorr FX Classifier. Duplicate now going in at Wright-Hargreaves, weighing close to 24 tons and raking 12,000 tons sand daily.



Above — Dorr Tray Thickeners and Pumps in a Canadian cyanide mill.

Right — Dorr F Classifier at Mount Morgan, Australia. Smaller unit of same type selected by Macassa.



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H. C. PARMELEE, *Editorial Director*

AUGUST, 1933

A Spur to Codes And Recovery

TAKING ADVANTAGE of a clause in the Industrial Recovery Act authorizing him to enter into agreements with employers, the President on July 27 launched an emergency drive against the forces of depression. This new expression of the partnership between industry and Government took the form of a voluntary agreement between employers and the President to set maximum hours and minimum wages for employees for the remainder of the year, pending approval of codes of fair competition. If the first enthusiastic response to his appeal can be taken as competent evidence, business shares with the President the confident belief that united action can successfully combat adverse economic conditions, and that it is not necessary to yield supinely to the process of letting the depression "work itself out naturally."

But the employment agreement is only a temporary step in the plan of recovery, an expedient to speed up the process of increasing purchasing power and keeping the ability to consume ahead of rising prices and volume of production. There remains the necessity of group agreements under codes of fair competition. In fact, the sharpest spur in the employment agreement is found in Clause 11, which commits the signer "to cooperate to the fullest extent in having a code of fair competition submitted by his industry at the earliest possible date, and in any event before September 1, 1933."

Codes are still not only essential but highly desirable. The employment agreement offers the employer no *quid pro quo*. It merely commits him temporarily to a national policy on hours and wages of labor. Under a code he may agree further with other employers in his own industry to abolish trade practices that stifle fair competition and profitable business, and can obtain governmental sanctions superseding antiquated restrictive clauses in the anti-trust laws.

The forces of recovery are moving. Cooperation is the order of the day. Hopefully the Administration regards the depression, not merely as a storm to be weathered, but as a plague to be eradicated by heroic measures of control.

Code Problems of Equipment Makers

NEW PROBLEMS in cooperation confront the manufacturer of mining machinery and mill equipment. Under the terms of the Industrial Recovery Act he is supposed to join with fellow manufacturers in a trade association that will submit a code of fair competition. But he finds himself in an unorganized industry making a diversity of products—drills, hoists, crushers, grinders, compressors, loaders, classifiers, agitators, concentrating tables, flotation machines, and a variety of related equipment. In many instances there is no existing group organization; in others there is a question as to the logical group to join; in some there is the prospect of having to join several associations. On the whole the outlook is perplexing, but there is light in the offing.

Sensing the predicament of machinery manufacturers, a group of sixty of them recently initiated action that resulted in the formation of the Machinery and Allied Products Institute. It is a federation of trade associations in the broad field indicated by its name, organized to coordinate the interests of machinery manufacturers in their relations with the National Recovery Administration. It will assist in the organization of affiliated groups, aid them in the preparation, and represent them in the filing of codes, and will prepare a basic code for the entire machinery and allied products industry, covering matters of common interest.

The formation of the Institute is a timely step. The manufacture of machinery and allied products is one of the five largest industries in the country. In 1929 it employed 830,000 men and paid them $1,400,000,000 in wages. But its diversity has been a barrier to cooperative action. Only about one-third of the industry has active trade associations; one-third is loosely organized, and the remainder wholly unorganized. Hence the great need for a coordinating body, not only to meet the present emergency, but also to establish the position of the machinery industry in the public mind on a level commensurate with its importance in our national life.

Mining machinery manufacturers will have to give thought to their individual problems, possibly organizing a trade association embracing the manufacture of mining and metallurgical equipment, or joining an existing organization that fits their needs. In either event, advantage should be taken of counsel and advice offered by the Machinery and Allied Products Institute. Further details about the organization will be found in our news columns.

Modernization and Industrial Recovery

LEANING over backward in their zealous efforts to cooperate with the Administration in formulating industrial codes, some groups have misconceived the place of modern equipment in relation to employment and efficient production. The Government's drive is to create and restore employment, but this is not to be accomplished by reverting to the era of hand labor and abandoning modern mechanical equipment. Nor is

it intended to throttle initiative, or invention and discovery of new and better processes and products. Some have erroneously thought to make a virtue of practically agreeing to stand still and make no progress while the Recovery Act is in force. There could be no greater folly. Almost anyone might get a brand-new idea in the next two years, and it would be unfortunate if his industry were so rigidly regimented as to preclude the possibility of adopting it. The Administration wisely rejects the fantastic notion. No premium is to be placed on inefficiency.

Admitting that the development of mechanical equipment has disturbed, and always will disturb, the *status quo* in employment, nevertheless the machine has much to its credit in improving products, reducing their cost, and expanding the sphere of their enjoyment. New industries and services have been created, offering new opportunities for employment. If social progress has failed to keep pace with scientific invention and engineering development, the burden of guilt cannot be laid wholly at the door of the latter. The machine has done too much to raise the standard of living to condemn it out of court.

In the present emergency it is vital to preserve a fair balance between the machine and employment. Under a policy of not selling below cost, the manufacturer will strive to reduce costs in order to gain markets. He cannot take it out of labor because he must pay the fair wage of his industry. Hence low mechanical costs are the answer to his problem. The only way a high-cost manufacturer, working with obsolete machinery, can compete is by reducing his mechanical cost by the use of modern equipment. So long as the net result of modernization is not to throw large numbers of men out of jobs, it is fully justified by its contribution to the general welfare. It was not the mere use of the machine that contributed to our troubles, but the greedy multiplication of mechanical equipment that resulted in expanding production beyond our capacity to buy.

Finally, it must be remembered that the depression cut deeper into the capital goods industries than it did into those producing consumer goods. Attendant unemployment was greater. Also, it must be remembered that the capital goods industries, as well as others, must be revived so that they, too, may again employ the hundreds of thousands dependent on them. Modernization of plant and factory has its legitimate place in the plan of recovery so long as capacity is not increased beyond the market possibilities. Let no producer be so shortsighted as to agree not to modernize his plant or bring out any new product during the period of recovery.

Blue-Sky Legislation At Washington

PROPONENTS of blue-sky legislation in the main comprise two groups: those who hold on purely moral grounds that the fraudulent sale of securities is an evil which, like any other evil, should be stopped, if possible; and those who also urge that such practice tends to injure legitimate promotion by making the promoter hesitant. For years these advocates have pressed for the enactment of a national blue-sky law that would meet their wishes. Such desires are in a measure granted by the Securities Act of 1933, although the new Act is probably not without its loopholes and does not insure that money raised by the sale of stock will be spent as promised by the sellers.

Those responsible for the enactment of the new law evidently recognize, as a general principle, that a fool or an ignorant person cannot be prevented from parting with his money. They have tried, however, to protect the investor so far as possible, by prescribing that a prospectus or similar document shall give adequate information about the security offered and that, above all, it shall tell the truth. Moreover, they have made those individuals upon whose statement, authority, or backing the purchase of the security is advocated, legally responsible for such use of their names. Under this law, new securities must be registered with the Federal Trade Commission, which body will regulate their issuance.

Of special significance to mining engineers is Section 7 of the Act, which prescribes that, if an engineer or appraiser is named in a registration statement as having certified any part of it, his written consent must first be obtained. He must also sign the statement. Likewise, his written consent must be obtained if he is named as having prepared a written report or valuation (other than a public official document) which is used in connection with the statement, although not prepared by him for that purpose.

As with all similar legislation, the question at once arises as to what effect the new law will have on the development of industry. Will it help or hamper? Certainly, it should aid in curbing the swindler who depends on the printed word to communicate his extravagant, lying patter. It will discourage the promotion of ventures, however honest, that have been conceived in ignorance and whose faults become manifest under the Commission's scrutiny. It will cause some brokerage houses to proceed more cautiously in soliciting their orders. In general, the fixation of responsibility as prescribed by the Act, and the resultant fear of suit or prosecution inculcated, should work at the outset to dampen the enthusiasm of promoters and underwriters for all except the most conservative projects. In the end, the law should prove beneficial, as a bulwark of honest business.

Scientific Determination Of Mine Openings

SCIENTIFIC research investigation on the part of educational institutions has been increasingly handicapped by diminishing appropriations as the period of adverse economic conditions has progressed. Although the situation was admittedly inevitable, and one that might have been expected under such unfavorable circumstances, the growing lack of financial support for this type of endeavor should occasion serious concern, especially because practically all new technical knowledge of recent years has come from the research laboratory. Any survey of the number of contributions made by scientific investigators would undoubtedly reveal a marked decline recently, a decline, moreover, that would probably be directly proportional in degree to the decrease in total funds available for such work.

This generally discouraging picture is brightened, here and there, by the unrestricted continuation of certain

research studies through the entire period of the last few trying years. One such project is discussed in this issue, in Professor Philip B. Bucky's article "The Design of Mine Openings." In this instance, the practical value of research investigation is strikingly apparent. Results already obtained are not only possible of immediate application in the mining industry but also indicate a new procedure in design that may be utilized in other branches of the engineering profession. To the mining engineer, the outstanding statement in the article will probably be that appearing in the conclusion to the effect that by the use of models and the application of the principles of similitude means are available for designing mine openings scientifically, and for studying the problems of ore extraction in a manner comparable with that employed by the members of the other branches of the engineering profession in determining the design of structures.

As Professor Bucky points out in the latter part of his article, new and larger apparatus that will materially broaden the field of the investigation is being constructed; equipment in which models of structures 3,000 feet square and having 1,000 to 2,000 feet of cover may be studied. This apparatus, involving the expenditure of a substantial sum, should provide further information of inestimable value to the mining industry. To Engineering Foundation and Columbia University, agencies sponsoring the investigation, unstinted commendation is due, particularly for the liberal financial support provided that has insured continuation of the study without interruption ever since its inception several years ago.

Gold-Standard Currencies And the Gold Miner

SOME of the more important phases of the situation in which the gold-mining industry of the United States finds itself during the present period of economic readjustment were discussed in these columns last month. In this issue several aspects of the industry, as viewed from the international standpoint, are considered. In the concluding section of the article, "What Price Gold?", for instance, reference is made to the uncertainty that obscures the future for the gold miner. This is probably the most formidable problem with which he has had to deal in recent years. The comment on the subject by Mr. P. M. Anderson, president of the Transvaal Chamber of Mines, quoted in the aforesaid article, is typical of the views voiced recently by many of the leaders of the Witwatersrand gold-mining industry. Ultimate return to the gold standard on a devaluated currency basis by those countries that have suspended it is the general theme that runs through their remarks. That thinking elsewhere is along similar lines is apparent in the recent statement of a high authority of the Federal Reserve Board of the United States, to the effect that a return of the country's currency to a gold basis would be advisable shortly, say in about six months. Another significant development is seen in the report, emanating from reliable sources, that at least one large Canadian gold producer is accumulating its metal output. This action may represent out-and-out commodity speculation, but probably a more accurate interpretation would be that it was the result of careful appraisal of the prospects for devaluation and stabilization of currencies on a gold basis that would yield a greater return on the company's metal than would its sale at current price levels, even though these levels represent a premium of more than half the prior gold-standard value. Existing conditions in the gold-mining industry are obviously not conducive to its sound development. Premiums may give a certain temporary financial advantage, but continued efficient operation of properties and retention of the investor's interest are largely dependent on the restoration of the gold standard for the world's currencies. The present trend of thought in this direction, plainly evident in the last month or so, should hold encouragement for the gold miner.

Physical Fitness In the Tropics

HEALTH is one of the most important assets a mining engineer should seek to conserve, especially when his work takes him where expert medical attention is unavailable, where perchance he may have to play the part of a pioneer in reducing the incidence to disease, to others as well as to himself; and the commonest ailment to which he is subject in the tropics is malaria. The immediate effects may not be considered serious, for the first attacks are usually short and recovery is prompt. But neglect of precautions and continued exposure to infection invariably lead to complications and distressing after-effects.

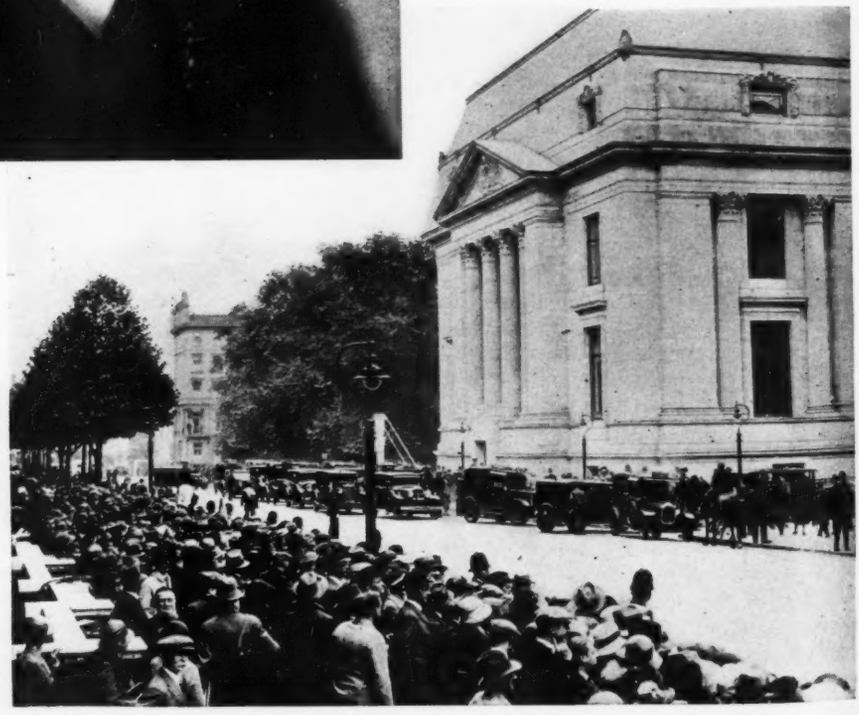
The discovery that malaria is transmitted by mosquitos, of one species only, was an outstanding contribution to the industrial and social progress of the tropics in the nineteenth century. It marked a significant achievement in the useful life of Sir Ronald Ross, who died less than a year ago, but whose fine work continues to be carried on through the agency of the Ross Institute and Hospital for Tropical Diseases at Putney Heath, a suburb of London, where many mining engineers have availed themselves of instruction provided by the medical staff, and are thereby better able to resist those tropical diseases that took so great a toll of life, and wrecked so many engineering enterprises, before the facts about the transmission of malaria germs had been made known. For those who are prevented by distance from attending the classes, and taking a personal interest in the conduct of the hospital, a vest-pocket booklet has been issued, entitled "Notes on the Prevention of Malaria," written by Mr. Cuthbert Christy, eminent as an authority on tropical diseases, and adviser during the War to the East African and Mesopotamian Expeditionary Forces.

This handy treatise discusses the causes, direct and indirect, of malaria—its symptoms, detection, treatment, and sequelæ. Advice is given to those in tropical countries on healthful living and sleeping conditions, as well as information on mosquito control, and the preparation of effective deterrents if extermination of the fly is not possible. No charge is made for this useful *vade mecum;* but those who wish to profit thus from the service being rendered in this branch of preventive and curative medicine are reminded that the Ross Institute is supported solely by voluntary contributions. To assist it financially is to recognize an obligation that should be felt by all who have escaped or suffered but slightly from the malaria hazards formerly considered inseparable from life in the tropics.

Harris & Ewing

KEY PITTMAN
Champion of Silver

THE bond of a quarter century between the mining industry and this United States Senator was forged in the early days of the Klondike rush. Fortune subsequently took him to the mining state Nevada, where he won and has ever since retained his present office. As the author of the Silver Act that bore his name, he exerted throughout its life a profound influence on silver mining in America. A changed world enlarged his horizon, gave him a new task and with it greater opportunity. The recent agreement of eight countries to restrict governmental sales and increase the use of silver, which is discussed on another page, is credited to his labors. Once again, the Senator scores for silver.



• Here, in the Institute of Practical Geology, at London, the recent International Economic Conference was held

The Jungle Rand

Mining Activity Revives on the Gold Coast

W. E. Sinclair

THE possibility of the Gold Coast ever becoming an important gold-producing country has been a subject of conflicting opinions for many years, and the sad memory of the catastrophic slump which followed the Jungle Boom naturally revives the atmosphere of suspicion in certain quarters whenever the subject of the Gold Coast is itself revived. This attitude is reflected in recent warnings uttered by city correspondents of the London press, in which they prophesy that burnt fingers are likely to result from following speculative movements in the West African gold shares.

Much water has flowed under the bridge since the calamitous failure of those hurriedly formed undertakings in the boom and slump of 1901-1914, and today the suspicions of these correspondents are seen to be unwarranted when thought is given to the changed conditions and the general advancement in that country as compared with the position a quarter of a century ago.

Those who have visited the Coast know that the gold undoubtedly exists, despite evidence of previous failures, and that there are, without doubt, possibilities of the development of a profitable mining field. Statements which confirm the suggestion that gold does exist on the Coast have been made from time to time by no less an authority than Sir Albert Kitson, and latterly this conclusion has been upheld by Major N. R. Junner, the present Director of the Gold Coast Geological Survey. Remarks made by Major Junner recently, in an address on the subject of the gold resources of the Gold Coast[1], are quoted in the following notes at some length, showing as they do that he is optimistic regarding the future development of the mineral resources of the Gold Coast and particularly with regard to gold. He supports his contention by emphasizing the fact, among other things, that the mineralized areas of the Pre-Cambrian rocks, such as those of the Gold Coast, are relatively favorable for the development of gold mines, and occurring, as they do, in rocks of Archaean origin, the lodes are likely to persist in depth. These assertions are also based on the extensive work of the Geological Survey in investigating the known orebodies thoroughly, and, further, in proving, by surface examination, that lode and alluvial gold is widely distributed over an area of 20,000 square miles underlain by mineralized Birrimian and Tarkwaian rocks of Pre-Cambrian age.

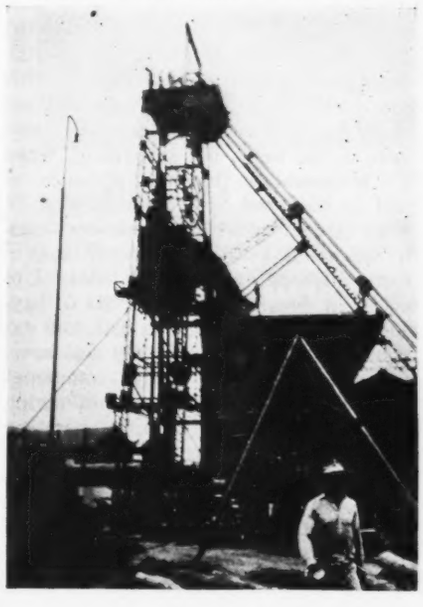
In face of these observations, and the substantial revival in the industry which has just set in, the question is often asked, why the bad name given to the Coast should cling, and why, in the first place, was there such wholesale failure, causing an unfavorable impression to prevail and persist.

The following notes, resulting from observations in the field, show the reason, from that angle, for the great slump that followed the Jungle Boom, which together with the effects of the Great War, in 1914, resulted in the collapse of the industry, which is only now regaining its feet after that knock-out blow.

The Coast

The local conditions of a place must have some bearing on industry and trade, and particularly when these conditions are a dominating feature of the country. So it is with the Gold Coast,

Prestea shaft, Ariston Gold Mines



Map of Gold Coast Colony, showing gold-mining districts and railroads leading to principal port

which is noted for its outstanding tropical features, and more especially its evil climate, its dank jungles, its transport difficulties, its labor, and its jujus.

The country obtained its second name, "the white man's grave," from the bad effect of the climate on the constitution of the average white man who ventured into its jungles. Wonderful efforts made by the men who have opened up the country have minimized the dangers of disease and death, but the unique conditions of this corner of the tropics will always be inconsistent with the country ever being made a healthy one for the white man. Nothing can ever be done to combat the discomforts of a hot, humid, and nerve-trying climate, which is only comparable to the interior of a steam laundry!

Another condition that materially affects the efficiency of the white staff on the Coast is the difficulty of the food question. Seventy-five per cent of the edible food which is not tinned consists of frozen meat, butter, and the like, obtainable, at some mines, from the fortnightly mail boat, at the nearest port of call. This lack of fresh food locally, and the custom of each man running his own mess (mine boarding houses have been tried out, but with no success), result in frequent cases of gastric trouble, usually put down to "fever," a convenient term used for many other ailments resulting from excesses not always connected with food!

The greater part of the country in which the mines occur consists of heavy jungle and undergrowth, the forest only being cleared to form the "camp," which is made up of the mine buildings and bungalows. The latter comprise the living quarters for the white employees, and, strange as it may seem, are constructed mostly of wood and galvanized iron, and consequently are like bake ovens during the day and night. Stranger still, in a country where the mosquito carries malaria and yellow fever and where many other less harmful but more aggravating insects

[1]"Gold and Other Mineral Resources of the Gold Coast." Address by Major N. R. Junner, London; 1932.

abound, the bungalows, customarily, are not mosquito-netted.

About 150 miles of railroad serves the principal mines in the Tarkwa, Prestea, and Ashanti districts from Sekondi (or Takoradi), the nearest seaport, as will be seen in the map of the country covering the gold field (page 317). Practically no roads are found in these districts, as the policy of the government is to discourage road making, and so prevent the introduction of motor traffic, which, the officials aver, might take away traffic from the railways. With few exceptions, the mines or prospects at any

Ashanti shaft at Obuasi

distance from the line are little further advanced in their methods of transport than were the pioneers of the field, 30 years ago.

These details, insignificant as they may appear to the outsider, are really extremely important in that they disclose some of the unusual features and trying conditions which the engineer meets and against which he must contend. A picture may also be drawn from the foregoing notes showing the extremely unsafe and unpleasant circumstances under which men labored before the building of the railways, and before any advance was made toward improving the wild state of the region.

Early Mining

Topographically, the country covering the gold belts consists essentially of forest-covered low hills, varying in height from 100 ft. at sea level to about 1,000 ft. at an average altitude of 800 ft. above the sea at a distance of about 159 miles from the coast.

The original gold won was worked by the natives by means of shallow pits which were sunk on alluvial gravels, or on the outcrops or outcrop rubble of reefs and lodes.

Apparently, the Portuguese were the first whites to work or trade in gold on the Coast, as early as 1471. More than likely, the natives actually worked the gold at that time, and possibly continued to do so from then onward, for, when the first white men penetrated the country in 1878, and opened up the first mines on the banket reef near Tarkwa, the outcrops were all exposed by extensive native workings. This date marks the commencement of the development of the gold field, and by 1895 various other gold reefs had been prospected and opened up, including the discovery of what has since proved the richest gold mine in the world, that of Ashanti Goldfields which, even today, treats ore averaging over 1 oz. per ton.

Those who have visited the Coast recently must continue to marvel at the fortitude of those men whose enthusiasm and courage kept them going under conditions which were more difficult than any that have existed in other fields. And yet, by 1901, nearly 150 companies, with a paid-up capital totaling nearly £9,000,000, were operating in the forests and jungles of the Gold Coast. This marked the height of the boom. Unfortunately, however, only a few of this large number of ventures withstood the great slump which followed the feverish speculation and mad gold rush of this period. The company promoter was not entirely responsible. Mistakes were also made in the field; not surprising, when one understands that the presence of gold is observed, without difficulty, in every stream and river bank, and even in the sands on the seashore, and in many outcropping reefs and lodes. Unluckily, it does not always occur in payable quantities, and in the rush and excitement of the boom this fact was overlooked. However, many companies failed not for lack of gold but owing to the extraordinarily high operating costs, due to transport difficulties, labor shortage, and other abnormal conditions which are bound to occur in a newly opened field in a new country like West Africa.

Only six of the mines which were started during the Jungle Boom were able to withstand the vicissitudes of the slump and the causes which led up to it, and are still working.

The principal registered mines which appear in the share market lists today are:

Akim; Ariston Gold (Prestea); Ashanti Corporation; Bibiani; Fanti Consolidated; Gold Coast Development; Lyndhurst; North Ashanti; Offin River; and Tarquah[3] and Abosso.

The tasks of the prospector and the engineer have been greatly lightened by the important work of the Geological Survey and the geologists and engineers attached to the different operating mines, in disclosing the various gold-bearing formations, mapping the geological features, and locating faults and dikes.

Much of this useful work has been done in the last ten years. As a result, greater confidence has been given to operating companies, and better work and more satisfactory results have been achieved by the engineers.

Following this deveolpment, work has been greatly expanded in the producing mines. In the past three years, this has been reflected in a steady increase in gold output, so that, in 1931, its value was £1,123,206, or nearly double that of the amount mined only three years earlier. This substantial increase does not include the premium which the mines obtained on the sale of their gold at the end of 1931; it has been achieved simply by improving working conditions through the adoption of more efficient methods and the introduction of new and up-to-date plant equipment.

The gold premium, which these mines are fortunate in obtaining, will serve as an added impetus to greater efforts. Besides being reflected in the increasing outputs of the producing mines, a revival is indicated by the fact that many old mines (which closed down during or since the slump) are reopening; and by renewed activity in prospecting and development work.

Mines which have reopened or are said to be starting work in the near future are the following:

Anfargah; Appolonia; Broomassie; Central Wassau Mines; Cinnamon Bippo; Effuenta and Fanti Mines; Kayiantor Block 1, Ltd.; and Oboum Mines.

Mining in this field may be classed under the three following headings:

1. *Dredging.* Many of the rivers whose courses follow the gold-bearing areas carry gold in their beds and banks. Some of these alluvials have been worked in a small way. Certain sections of a few of the rivers have been dredged. Dredging and other forms of alluvial mining, however, have not been very successful. The failure of various dredging operations is said to have been due to the fineness of the gold, which is a feature of the alluvial occurrences in

[3]Tarquah is a variation in the form of spelling Tarkwa.

this field. It is odd, in this connection, that the natives are able to effect a clean recovery of the gold contents of the alluvium, by their primitive calabashing methods, and are even able to wash "tailings" with fair success. Their skill in this work may account for the fact that in prospecting alluvials in the past, high values of the ground have been obtained that could not be recovered by the mechanical gold-saving devices of those days, simply because of the fineness of the gold.

Alluvial gold has been worked in a crude fashion by natives in many parts of the country, but more especially on the banks of the Ankobra, Offin, Pra, and Fura rivers, where dredging has also been done over certain lengths.

2. *Mines on Banket Reefs.* Two known Gold Coast banket formations are similar to those of the Rand. One formation occurs in the Tarkwa district and the other in Ashanti. The former is the better-known reef and is being worked at present by the Tarquah and Abosso Gold Mining Company, Ltd., and the Akoon Syndicate, operating the old Abontiakoon mine.

The banket beds in this district dip on an average at 45 deg. and in all respects closely resemble the Witwatersrand reefs, and are worked in the same manner, except that, at the comparatively shallow depths (about 2,000 ft.) at which they are being worked now, stopes are left open, only a small amount of stull timber being used for ground support. Rockbursts are unknown and the question of stope filling is not urgent. (The view on this page of the Abosso mine plant is reproduced from "Memoir 1," Gold Coast Geological Survey.)

Working costs, under these conditions, average about 20s. 10d. per ton. They do not compare favorably with Rand costs, despite the shallower working depths and the advantages of cheap skilled labor.

In this field, ore lower in value than 6 dwt. per ton is considered low grade, and under ordinary circumstances is unpayable, although much of this will now be included in the ore reserves since the mines appear to be assured of the premium on gold.

The annual output from the mines[3] in this district for the year ended March 31, 1931, was 200,837 tons, from which 64,280 oz. of gold was recovered.

3. *Mines on Fissure Reefs.* Two known fissure gold-bearing channels cut across the Gold Coast. At several so-called gold-quartz mines are exploited payshoots or lenses made up of mineralized brecciated graphitic schists and quartz veins which constitute the fissure channels. The best known is the Ashanti channel, on which are operating the Ashanti Goldfields and Bibiani, Ltd., among the well-known northern mines in the country. The second channel is the Prestea gold belt, on which the Ariston Gold Mines are working and on which the old Broomassie mine extracted nearly £1,000,000 worth of gold in the upper levels before it closed down in 1914.

Both of these fissure orebodies are similar in their lenticular mode of occurrence. The mines referred to as working on these fissure lodes are evidently established on well-defined lenses. Every reason indicates that many other lenses of equal importance remain to be located along the strike of the channels, or at greater depths, where they now show no outcrops.

The Ashanti orebody occurs in three parallel zones of fissuring which are from 5 to 50 ft. wide and dip at 80 deg. from the horizontal. The country rocks consist of crushed carbonaceous sericite schists, which generally constitute extremely weak walls, and make ore mining difficult. At the Ashanti the orebody itself constitutes treacherous ground, difficult to work because of its graphitic nature, consisting as it does of alternate bands of quartz and graphite (streak bacon structure). This weak formation is aggravated by a very usual footwall band of graphite which causes the ore across the whole width to break away easily. Mining under these circumstances consists essentially of holding up the ore by means of square-set timbering, while the walls are supported by close sand-filling.[4] The ore generally contains, in its graphitic part, about 3 per cent of arsenides and sulphides, which carry some of the gold. Its refractory nature and the tendency toward premature precipitation of the gold on graphite in the cyanide solution require that, after dry crushing, the ore be roasted, before leaching.

Working costs on these orebodies average about 28s. 9d. per ton, but will now be reduced owing to the premium. For the same reason, ore below 9 dwt. in value, which has previously been classified as unpayable, will now be included in the reserves.

Output of the Ashanti Goldfields for the year ended March 31, 1932, was 151,597 tons, from which was recovered 174,118 oz. of gold, an increase in both tonnage and recovery as compared with previous years. (The view of the Ashanti shaft reproduced is taken from an article by W. R. Feldtmann, *Mining Magazine*, May, 1916.)

In the Prestea belt, the orebodies, like the Ashanti lodes, occur in three parallel zones. They resemble these lodes in many other details, but also differ in salient features—for example, width of reef, which varies from 6 to 20 ft. and averages only 13 ft. The various reefs incline at a flatter angle, averaging from 60 to 70 deg. from the horizon. Structure of the orebody, though roughly similar to that of the Ashanti lode, is not so definitely banded, and consists chiefly of quartz, with carbonaceous schist largely replacing the graphite. The fissure walls or country rocks consist of sericitic schists, with bands of graphitic schist in them; and, although the structure is not crushed or broken, it is nevertheless weak. The walls stand well for some time after removal of the reef, but exposure eventually causes weathering, and the effect of this, combined with the weight and pressure of the unsupported ground, soon causes complete collapse. Shrinkage stoping was practised at one time, but without success.

The Abosso gold mine

Mining is successfully practised today by underhand stoping methods, without the square-set timbering used in Ashanti, sand-filling being used only for supporting ground.

Metallurgy

Metallurgical treatment is simpler than that of the Ashanti orebody. A good extraction is obtained without cal-

[3]Tarquah & Abosso, and Akoon Syndicate.

[4]"Stope-filling," by the author. *Mining Magazine*, Sept., 1932.

cining, the troublesome graphitic content being removed by passing the ore, after wet crushing by stamps and tube mills, over plates and a large area of tables, the concentrates from which are treated in the usual way.

Lower working costs, averaging about 25s. per ton, enable ore of 7 dwt. yield per ton to be worked at a profit.

The amount produced by the Ariston mine, on the Prestea gold belt, for the year ended March 31, 1932, amounted to 60,014 tons, from which was recovered 25,997 oz., a substantial increase on previous efforts.

Many factors besides those mentioned contribute to the successful results achieved by the mines now, as compared with those of 30 years ago. One, as on any field, is the question of efficient labor.

At the producing mines on the Coast today, about 200 white men and 10,000 natives are employed. In recent years, the managements have given much study to this question, realizing that, first, the right type of man is essential, and, second, that maintenance of the efficiency of the staff is vital. This point is to some extent achieved by regulating each man's working period at the mine, and limiting his "tour," as far as possible, to twelve months. Demonstration has been made at one mine in West Africa, with an average staff of nearly 100 men, that of those who continued to work on beyond a period of 270 days, not one in ten failed to appear on the sick list. This would indicate that the average tour should be no longer than seven months. Most white employees on twelve monthly contracts are given three months leave on half pay, and are paid their passages and expenses to and from the mine on the completion of each tour. The expenditure thus incurred tends to make white wages comparatively low. Also, the average white employee is considered more of a supervisor of labor than an active worker.

Owing to the comparatively short "tours," an unusually large white staff must be maintained, or companies are faced with a problem of non-continuity of service, a difficulty which is aggravated by the overlapping of staff or a shortage when men have not returned to relieve those whose contracts have expired.

The native tribe known as the Appolonians are believed to be the original miners on the Coast, but today most tribes are represented on the mine payrolls. All labor is voluntary, and the mines are relieved of the responsibility and cost of feeding and housing their native employees. Whether the advantages of this voluntary system entirely outweigh the disadvantages, such as shortage of labor and incomplete control, is questionable. The extensive development of the cocoa industry in the country absorbs large forces of labor at certain seasons and dislocates the regular supply for the mines.

On the Coast the usual mine labor may be broadly divided into two classes: skilled artisans and the laboring class. The former are made up of many tribes, and are superior in intellect when compared with the South American native, especially in aptitude for learning mechanical trades. Ape-like intelligence, coupled with the proverbial patience of the negro, makes these natives capable of executing all the work usually assigned to the skilled white artisan. Native engine-drivers, turners, fitters and electricians, and the like, earn from 5 to 10s. per 8-hr. shift. The question as to their efficiency and whether they accomplish their work at the same rate as their white counterpart is a dubious one; but they can do work under conditions unsuitable to the white man.

The other class, the native laborer, is an inferior worker as compared with the average native in other parts of Africa. This may be due to poor physique. Laborers are paid at the rate of 1s. 6d. to 2s. 6d. per shift, from which they feed and house themselves.

Generally speaking, the Gold Coast native is a spoilt example of the species, and owing to the ruling policy of equal status for blacks and whites, is of an independent nature, which often adds to native labor problems.

This gold industry, then, is growing up in spite of a false start. The foresight and indomitable spirit of the pioneers is reflected in the sound mines of today, which are business organizations built up as a result of costly experience gained in the failures of the past. The climate remains the only handicap to complete success, and yet, if this was faced without thought of danger 30 years ago, enthusiasm and success today should make nought of such a small disadvantage.

Royalties of 5 per cent from the gold mines, with the indirect benefits which accrue from the industry, have brought wealth to the Government, and the industry has proved itself an important factor in the development of the Colony. In view of this and the foresight of the Government in fostering the industry, it has naturally been ready to give every assistance to the mines, especially through the Mines Department. This attitude has undoubtedly helped the present revival.

Heavy Fluid Separation

Laboratory Work Proves New Process Effective

C. Erb Wuensch

FOR SEVERAL YEARS I have been intrigued by the excellent metallurgical results attainable by laboratory "sink-and-float" tests, using a chemical of high specific gravity, to effect the separation of the mineral constituents of an ore from a relatively coarse unsized feed. Unfortunately, the cost of such chemicals is so great that the inevitable small losses render their commercial use prohibitive. Many attempts have been made to substitute finely comminuted heavy minerals or solids suspended in water to form a pulp (variously called heavy-fluid, fluid-mass, or medium) for the chemicals. Their use has been successful in coal washing, where pulp density need not be controlled to a nicety for economic results, because of the relatively wide gravity range between the various "bone" particles varying insensibly from "coal" at one end to "refuse" proper at the other. These particles act as a safety valve in controlling the separation. Further, the operation is the reverse of that required in ore concentration. In coal washing the coal floats as a tailing and the refuse sinks. Also, the contamination of the medium and its recovery present a simpler problem, where the refuse slimes, to a large extent, may constitute the separatory medium, than in ore concentration where gangue slimes contaminate the medium and the recovery of the medium is likewise of vital importance.

Two years ago, after considerable experimentation, I developed the "differential density" separation process, which involves creating in a cone a separating medium having the specific gravity at the top less than that of the lightest particle, and at the bottom heavier than the lightest particle. This is maintained by introducing the heavy thickened medium at the bottom of the cone under a slight head so that it diffuses upwardly and forms, at some mid-point, the proper specific gravity to effect a separation. As more feed is introduced, a crowding action results, which crowds out the tailings and sinks the middlings. The separatory effect is the resultant of the combination of the medium and the middlings bed. This process has been successfully applied in washing coals in Kansas.

Since then, I have done considerable work to develop the art further in its application to ore concentration and to make possible ultra-delicate separations

in large-scale continuous operations. This work involved the elimination of the deleterious effects of the "middlings" accumulation in the medium column; proper preparation of the feed to minimize the medium contamination; proper preparation and automatic control of the medium density; compensation and control of velocities in the separation bath to minimize "crowding"; refinements in medium recovery, medium purification, and circulation in the circuit to minimize losses and contamination with gangue slimes. In the new work, as many as five separate products can be made in one step, as, for example, a "tailing," "light middlings," "heavy middlings," "heavy concentrate," and "light concentrate." The name "hetero-concentration" has been coined to designate the new process, which, as the word "hetero" implies, is a combination of many different concentration and ore-dressing principles. This process has not been applied commercially as yet, but enough work has been done to indicate the probability of its success in large-scale operations. A pilot plant is under construction for use in making tests in several fields of application.

The most important and promising application of the process is in the preliminary concentration of low-grade ores or minerals of low economic value, by eliminating at very low cost a large percentage of practically barren material from the mill feed after coarse or intermediate crushing, to produce a greatly enriched product for finishing treatment by the usual but more expensive current milling methods, involving fine grinding, flotation, or cyanidation. Numerous tests have been made on low-grade ores of gold, silver, lead, zinc, iron, and quicksilver, also coal, beryl, and fluorspar, with better metallurgical results than could be obtained by other gravity methods. The process has failed to be applicable in many types of gold, silver, and other ores where the values were finely disseminated; the values must accompany sulphides or favor one or more gangue minerals in preference to others, or else no gravity separation will be possible. Almost perfect separations can be made where a difference of as little as a tenth of a point in specific gravity exists, whereas other methods of gravity concentration require a difference of a half to a tenth of a point.

In general, even in favorable types of gold-silver ores, where the precious-metal content is above $4 or $5 per ton, better economic results can be obtained by flotation or other current methods involving fine grinding, because the relatively higher recovery offsets the economies in costs afforded by use of the process. However, for low-grade ores or minerals of low economic value, where applicable, economies can be effected by its use. The process might be termed mechanical sorting, applicable to separating unsized materials ranging from 20 mesh to 2 in. or more, at a cost of less than 10c. per ton, and capable of rejecting a large part of the material as a tailing that would not justify further treatment; thereby making an enriched mill feed which could be milled by more costly current methods. Materials finer than 20 or 30 mesh cannot be successfully treated, because of the impracticability of separating the medium on screens of fine mesh and the difficulties involved in preventing medium losses and contamination. The accompanying table shows results obtained with the process.

Jig Tails From Tri-State Zinc District
Size, — ½-in. plus 20 mesh
Grade
Heads, 2.60% zinc
Tails, 0.61% zinc
Concentrates, 24.50% zinc
Ratio of concentration, 12.0 : 1
Recovery, 76.6%
Note: This same material was re-treated by jigging, with the following results:
Grade
Heads, 2.60% zinc
Tails, 1.25% zinc
Concentrates, 7.20% zinc
Ratio of concentration, 5.1 : 1
Recovery, 52.0%

California Quicksilver Ore
Size, — 20 mesh, { 22% by weight, 10.2 lb. quicksilver
— ½-in. plus 20 mesh, { 78% by weight, 5.3 lb. quicksilver
Grade
Heads, 5.3 lb. Hg.
Tails, 1.0 lb. Hg.
Concentrates, 62.8 lb. Hg.
Ratio of concentration, 14.3 : 1
Recovery, 81.2%

Nevada Beryl Ore
Size, — 20 mesh, 7.5% by weight
— ¾-in. plus 20 mesh, { 92.5% by weight, 1.0% BeO
Grade
Heads, 1.0% BeO
Tails, 0.07% BeO
Concentrates, 8.1% BeO
Ratio of concentration, 8.6 : 1
Recovery, 93.0%

Colorado Gold Ore
Size, — 20 mesh, 27% by weight, $4.30.
— ½-in. plus 20 mesh, 63% by weight, $1.57
Grade
Heads, $1.57
Tails, $0.22
Concentrates, $16.08
Ratio of concentration, 11.7 : 1
Recovery, 86.0%

California Gold Ore
Size, — 20 mesh, 14.6% by weight, $12.60.
— ½-in. plus 20 mesh, 85.4% by weight, $2.35.
Grade
Heads, $2.35
Tails, $0.60
Concentrates, $9.10
Ratio of concentration, 4.7 : 1
Recovery, 74.5%

The capacity of a plant per unit cost is great compared to a flotation or cyanide plant. In general, a combined "hetero-concentration plant" with a flotation plant to handle the original fines (—20 mesh material) and the concentrates made with the new process will cost about one-third to one-fourth of an "all-flotation mill." The medium loss will average about 1 lb. per ton of feed. Water consumption is about 2 to 3 g.p.m. per ton-hour capacity, as compared with 12 to 15 gal. in the average flotation plant.

Amalgamating Copper Plates

COPPER PLATES may be readily and inexpensively amalgamated by a new method employing a soft mush composed of ammonium chloride, 80 per cent, moistened with 20 per cent of water, and sufficient mercury dispersed through it.

In carrying out the amalgamation, a large, shallow, enameled pan (iron is not suitable, nor is any metal which amalgamates with mercury), or a watertight wooden box of the same dimensions, will serve very well as the receptacle for the cleaner mush and in which the amalgamation can be conveniently carried out.

Into the pan is weighed several pounds of gray or white ammonium chloride and the requisite amount of water; then a quantity of mercury is added which will be more than enough to amalgamate all of the copper plates. The mercury should be broken up into fine droplets and dispersed throughout the sal ammoniac mush. The plates are now simply scoured with this mixture, which quickly removes the oxide film from the copper plates by the combined solvent and abrasive action of the ammonium chloride. Excess salt and mercury are wiped off into the pan and the plates washed with water. The pan containing the amalgamating mixture should be kept covered until again required. Caking due to loss of water is nothing serious, as a little water will again restore the mixture to a workable condition.

Grease on the plates offers little interference to amalgamation of the copper, but it should be removed, as it will prevent amalgamation of the gold. The film of copper oxide which normally forms on any amalgamated surface, although quite readily removed by pulp scouring action, is more positively removed with less loss of floured mercury by having the circuit past the stamp battery or tube mill slightly acid with sulphuric acid.

The mixture described in the foregoing has none of the disadvantages which are present when using known methods of amalgamating copper plates, and is harmless to the operator doing this work.

Design of Mine Openings

Application of the Principles of Similitude Develops Fundamental Data

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THIS PAPER, which is based on a research project of Engineering Foundation and Columbia University, has for its purpose the presentation of a scientific method for determining the proper span and roof shape to be used underground for safe and economical mining. At present these factors, of much importance in all mining systems where pillars are left to support the roof, are determined by local practice or the experience of the individual in charge. Inasmuch as the size and shape of a mine opening, especially if it is a stope or room, is the basis on which mine planning is done, better planning will result if these factors are scientifically determined. In addition, savings in extraction and development costs will result, and underground workings will be safer.

Hundreds of miles of tunnel are driven yearly in ore- and coal-mining regions for development and prospecting purposes, in addition to work of a similar nature being undertaken for subways, railways, and water supply. The question of arching these is an important one. Does arching increase their strength? The results of experiment show that for certain conditions arching weakens the structure around an opening. For others arching has a beneficial effect. Progress has now been made to the point where some of the factors affecting arch strength and their relative effects on the strength, behavior, and design of arch structures are known.

The solution of these problems is obtained by the observation of model behavior and the application of the principles of similitude. These principles are the laws or relationships which make it possible to determine from model behavior the behavior of the prototype. The fundamental relationships, which have been explained in detail,[1] may be here briefly summarized as follows: A scalar model of any weighty structure will behave similarly to its prototype if the model and prototype material are the same, and if the model weight is increased in the same proportion as its linear dimensions are decreased. The effect of an increase in weight is obtained by substituting a centrifugal field of force for the gravitational one, the model being placed in a suitably designed centrifuge.

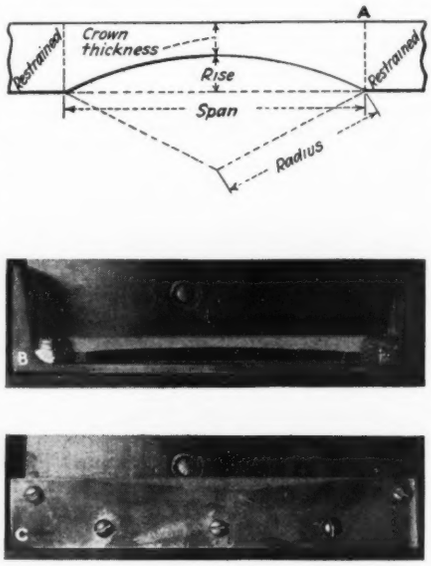


Fig. 1—Type of arch structure used for investigation

A — arch elements. B — model arch in holder for testing. C — jig for model preparation

To make the preceding statement clear, assume that a model of an arch built to a 1 to 1,000 scale is placed in the centrifuge and rotated at a speed such that its normal weight is increased 1,000 times. A model to represent a 1,000-ft. span with a 5,000-ft. radius of arch would have a 1-ft. span and 5-ft. radius of arch. The principles of similitude, in this instance, state that if a crack occurs 0.2 ft. to the right of the center in the model a similar crack will occur 1,000x0.2, or 200 ft., to the right of the center in the prototype. If the model deflects 0.01 in. at the center, the prototype deflection at the center will be 1,000x0.01 in., or 10 in. If, on investigating a block-caving method, the size of particles that the model block caves to is 0.01 in., and the scale is 1 to 1,000, then the size of particles that will result in caving the prototype will be 1,000x0.01 in., or 10 in.

To develop the solution to this problem, sandstone arch structures were used, as shown in Fig. 1. The factors that affect the model strength and behavior are span rise or radius, crown thickness, and restraint. To determine the effect of each factor, all others must be kept constant. In model solutions all factors are under definite control, and the effect of each, separately or in combination, may be determined. In Fig. 1, if the span and radius are kept constant, the rise must be constant, for with a given span or chord and radius, the middle ordinate is fixed. Restraint is taken care of by having sufficient extent of structure beyond the arch curve and holding the model in place with type metal. The remaining variable is crown thickness. By using arches with different radii and varying the crown thickness of each, the effect of any single factor may be obtained.

Models are prepared from the material under investigation. At the present time the materials used for test purposes are sandstone, limestone, and clay. In this paper, the behavior of sandstone models will be discussed. Rectangular pieces, about 8 in. long, 1 in. wide, and of variable height, were first cut. Each piece was placed on a steel jig, see Fig. 1—C, having proper radius of arch. The arch was then cut to conform to the jig by emery wheels, files, and abrasives. The model was next set in the model holder, both were placed in the centering and pouring device,[2] and then the type metal was poured. Fig. 1—B shows the model in the holder. After balancing,[1] the model was placed in the centrifuge, its behavior observed by means of a stroboscopic light, and readings were taken.

Fig. 2 exhibits the experimental results. The curves show the model ratios at which arch structures with a given radius of curvature failed, plotted against crown thickness. The data from

[1]Technical Paper 425, A.I.M.E., 1931: "The Use of Models for the Study of Mining Problems."

[2]For details and description of these devices the reader is referred to Contribution 4, A.I.M.E., 1933: "The Effect of Approximately Vertical Cracks on the Behavior of Horizontally Lying Roof Strata."

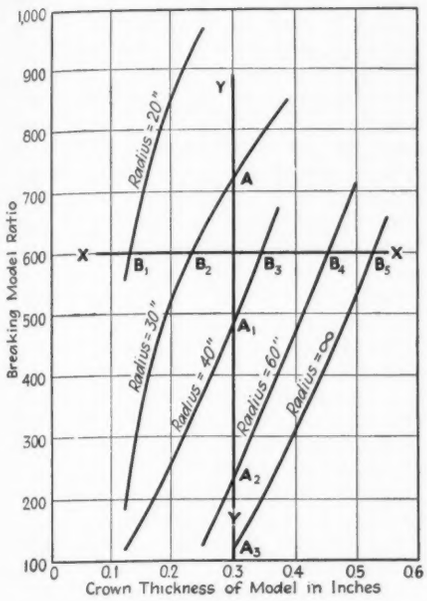


Fig. 2—Sandstone arch model curves. Constant span of 6.5 in. used for all models.

which these curves were drawn are available, and will probably be presented in the near future. The term "model ratio" in these curves represents the number of times of normal model weight the model is loaded to, at failure.[1] This fact provides a means of comparing the relative strengths of structures of different shapes.

For example, the 30-in. radius curve, which refers to a group of models with the same radius of arch and span and variable crown thickness, shows that a model with a $\frac{1}{8}$-in. crown thickness failed when its load was 181 times its normal weight, and that a model with a $\frac{1}{4}$-in. crown thickness failed when its load was 637 times its normal weight. Therefore, the model with the $\frac{1}{4}$-in. crown thickness is at least $\frac{637}{181}$, or 3.52, times as strong as that with the $\frac{1}{8}$-in. crown thickness. Increasing the crown thickness to $\frac{3}{8}$ in. increased the load at which failure occurred to 835 times its normal weight. In these models the span rise and radii were the same, the only variable being crown thickness. The 40-in., 60-in., and infinity radii curves substantiate the results of the 30-in. curve discussed here. Experimental evidence indicates that, for the type of structure and limits tested, increasing the crown thickness increases the strength of the structure. An arch with an infinity radius curve is a flat beam. Note that a flat beam 0.4 in. thick is stronger than an arch structure with a 40-in. radius and 0.17 in. thick. The flat beam fails at a model ratio of 300, the arch structure at a model ratio of 200.

In Fig. 2, line Y—Y is drawn parallel to the Y axis, so that it cuts the 30-in., 40-in., 60-in., and infinity radii curves at points A, A_1, A_2, and A_3. Crown thicknesses of the model represented by the above points are all equal to 0.3 in. Point A_3 represents a model whose arch has an infinite radius, which fails at a M.R. (model ratio) of 118; A_2 a model with a 60 in. radius arch, which fails at a M.R. of 235. These results show that if crown thickness and span remain constant the load that this type of arch structure will carry increases as the radius decreases.

In Fig. 2, line X—X is drawn parallel to the X axis, so that the curves for the various models are intersected at points where model ratios at failure are the same, which means that the arch structures represented by points B_1, B_2, B_3, B_4, and B_5 will each fail when loaded to 600 times their weight. For example, all the arch structures listed in Table I have the same strength. Arch structures of variable over-all heights and radii, as indicated in the accompanying table, may have equal strengths for the same span.

If the curves of Fig. 2 be discussed on the basis that model behavior is similar to that of the prototype, the curve of the 30-in. sandstone arches shows that a model with a 30-in. radius arch, 6.5-in. span, and $\frac{1}{8}$-in. crown thickness fails at a model ratio of 181. That is, a prototype built of the same material as the model will behave like the model if its dimensions are as follows: span, 6.5 in. x 181 ÷ 12 = 97.92 ft.; radius, 30 in. x 181 ÷ 12 = 452.5 ft.; crown thickness, $\frac{1}{8}$ in. x 181 ÷ 12 = 1.88 ft. From this curve, therefore, the dimensions of the prototype at which failure will occur are obtained by multiplying the model dimensions by the model ratio at failure.

The data presented so far relate to models stressed to the point where failure occurs. The problem now is to determine, from the data available of models that have failed, the proper design for a safe structure. In designing surface structures, a safety factor of from 4 to 10 is used, the factor adopted being determined by the local building code. If a model fails it has evidently been stressed at its place of failure to its ultimate strength. Assuming a safety factor of 4, the problem is one of determining the dimensions of the prototype that will give maximum unit stresses $\frac{1}{4}$ of those in the model at failure.

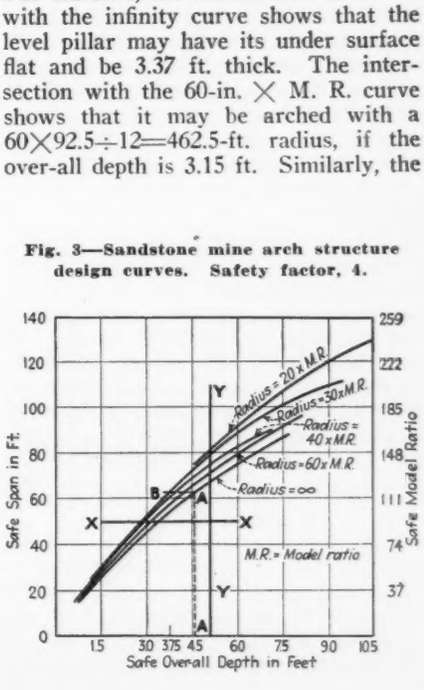
Experimental results[1] show (1) that unit stresses at similar points in model and prototype are the same; (2) that the unit stresses at any point in a model vary as the model ratio. Hence, if a model fails at a model ratio of 1,000, and its unit stresses at failure are equal to 4, a similar model rotated at a speed equivalent to a model ratio of 250 will have unit stresses of 1. Therefore, with a safety factor of 4, applied to mine structures, the prototype dimensions should be equal to the model dimensions multiplied by $\frac{1}{4}$ the calculated model ratio at failure.

In Fig. 2, therefore, if the points are moved to a model ratio corresponding to a safety factor of 4, a set of curves result as shown in Fig. 3. These curves are drawn to give the correct model ratios to be applied to model dimensions, so that the mine structure will have a safety factor of 4 and be as safe from a structural point of view as any surface building. On this curve, safe over-all depths are plotted against safe spans and safe model ratios.

From the set of curves in Fig. 3 the following questions may be answered: **What radius of arch is required for the assumed material, if the thickness is 3.75 ft. and the span desired is 60 ft.?** Follow the base line marked "Safe Over-all Depth" to point 3.75, above which the safe span for a flat roof (infinite radius) is found to be 54 ft. It therefore must be somewhat arched. For a 60-in. x M.R. arch, the safe span is 57.5 ft. As this is insufficient, further inspection reveals that a roof with 40-in. x M.R. arch will support safely a 60-ft. span. At the right-hand side is found the equivalent model ratio of 111. The radius of curvature of the arch therefore will be $111 \times \frac{40}{12}$, or 370 ft.

A set of these experimental curves developed for a given case will be useful in determining the safe dimensions and shapes for mining structures. **Guesswork is here replaced by scientific data. For example, in working a vertical deposit of 50-ft. thickness by overhand stoping, the shape and dimensions of level pillars may be determined as follows:** On Fig. 3 at the 50-ft. span mark, draw line X—X. This cuts the curves at points, each of which determines the dimensions and shape of level pillars having about the same strength. For instance, the intersection of X—X with the infinity curve shows that the level pillar may have its under surface flat and be 3.37 ft. thick. The intersection with the 60-in. × M. R. curve shows that it may be arched with a 60×92.5÷12=462.5-ft. radius, if the over-all depth is 3.15 ft. Similarly, the

Fig. 3—Sandstone mine arch structure design curves. Safety factor, 4.



[1] *Ibid.*

intersection with the 40-in. × M. R. curve shows that, if arched with a curve whose radius is 40×92.5÷12=308.3 ft., its over-all depth need be 3 ft. The conclusion is that the ore tied up in level pillars may be reduced by adopting correct dimensions and shapes without affecting strength.

Another general type of problem solvable from these curves is that of determining economic spans. If line Y—Y in Fig. 3 be drawn, and the thickness of the material is known, with the roof material 5.1 ft. thick, which is equivalent to the total depth on Curve 5, a flat roof allows a safe span of 68 ft., whereas if the roof is arched with a curve whose radius is 30 in. × 148÷12=370 ft., the span that may be worked is 80 ft. The increased safe span with this arch is 12 ft., or 18 per cent. The desirability of arching the roof in stopes and rooms being a question of economics, the effects may be readily calculated.

Data similar to those shown in Fig. 3 were obtained for limestone arch structures and combined as shown in Fig. 4. Similar curves for plain concrete, reinforced concrete, wood, or other material might also be shown. Furthermore, the shape of the arches may be changed to the parabola and catenary, giving still another group.

As an example, assume that a choice of either sandstone or limestone is to be made for an arch having an 80-ft. span and a safety factor of 4. By drawing line X—X shown in Fig. 4 through the 80-ft. span, structures represented by points 1 to 7 are shown to satisfy all requirements. Point 1 represents a limestone structure whose radius is $\frac{40 \times 148}{12} = 193$ ft., over-all height 2.85 ft., and span 80 ft. Point 7 represents a sandstone arch of infinite radius, 80-ft. span, and 6.02-ft. thickness. The dimensions and shapes of structures represented by the other points may be similarly determined. All these structures are of about equal strength for an 80-ft. span, but of varying shape and material. By computing the amount of material necessary for each structure, the minimum amounts and costs can be found.

In this figure points C_1, C_2, and C_3, where curves for the limestone and sandstone structures cross each other, represent structures of the same strength, span, and over-all height, but of different arch radii. Thus, inasmuch as the 40-in. limestone curves intersect the 20-in. sandstone curve at C_2, a limestone structure with a 100-ft. span and an arch radius of $\frac{40 \times 185}{12} = 616.6$ ft., and an over-all depth of 6.75 ft. has the same strength as a sandstone structure with a 100-ft. span, a radius of $\frac{20 \times 185}{12}$ = 308.3 ft., and an over-all depth of 6.75 ft. Hence the sandstone structure will take less material, and attention is directed to the fact that structures of weaker material properly designed may need less material for the same strength than if built of strong material and improperly designed.

The foregoing discussion relates to the type of arch shown in Fig. 1—A, which is important from a structural point of view and as a basis for studying more complicated designs. It is, however, a type seldom met in practice, except in steeply dipping orebodies. Most mining structures are of stratified layers overlying the material being mined, and in which the roof arch is made. In studying the behavior of such arches loaded with different materials, the experimental work was limited to a single stratum of varying composition and thickness (see Fig. 5). In all tests made, as previously explained, the arch was of sandstone, the overlying strata being sandstone, limestone, and clay. The interesting points of this work may be summed up as follows: Curves similar to those of Figs. 3 and 4 may be drawn, and, if the thickness of roof material and cover are known, the workable span for any radius of arch may be determined. The corollary, the determination of the arch radius for a definite span, may also be obtained from these experimental curves. These results are of special interest to those using loading machines in room-and-pillar work, inasmuch as more economical use of a costly machine may be obtained if the room span is sufficient to allow free movement of cars. Other interesting points are that the load on the arch structure decreases as the thickness of the bed overlying the arch increases, and also as the modulus of elasticity of the material increases. A clay cover loads an arch enormously, as compared to a limestone cover. Further information on this important subject is available, and will probably be presented in the near future.

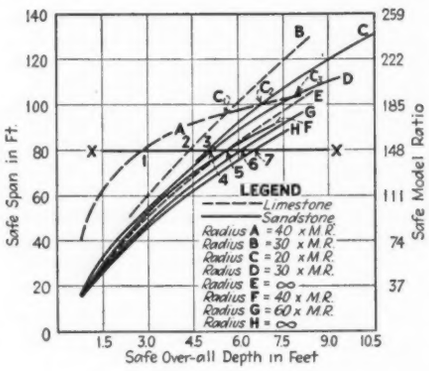
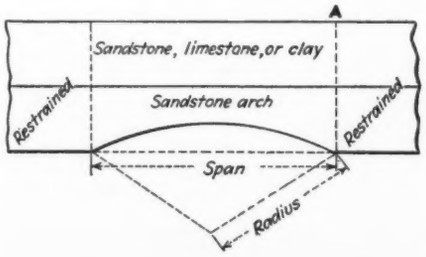

Safe Span in Ft.
Safe Model Ratio
Safe Over-all Depth in Feet
LEGEND
Limestone
Sandstone
Radius A = 40 x M.R.
Radius B = 30 x M.R.
Radius C = 20 x M.R.
Radius D = 30 x M.R.
Radius E = ∞
Radius F = 40 x M.R.
Radius G = 60 x M.R.
Radius H = ∞

Fig. 4—Sandstone and limestone safe arch structure design curves



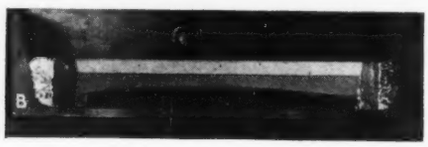


Fig. 5 — Experimental type of loaded arch structure

A — arch elements. B — model arch in holder for testing

Summary and Conclusion—The material presented here is a small part of that available. The use of models and the application of the principles of similitude offer at present not only a means of scientifically designing mine openings but also a means of studying the problems of ore extraction in a manner available to workers in other fields. Only a very few of the problems that lend themselves to this type of solution have been discussed here, and the presentation of the information made available by the curves was by no means exhaustive. The present apparatus necessitated working with small models and at comparatively small model ratios. New apparatus is being built, to be available in early September, where models of structures 3,000 ft. square and having 1,000 to 2,000 ft. of cover may be studied. Problems now being undertaken in the laboratory deal with pillar behavior and design, and block caving.

Experimental work for this paper was performed by A. L. Fentress, a graduate student. To Professor Robert Peele I am indebted for his careful reading and criticism of the manuscript.

Table I—Arch Structures of Equal Strength

Model Dimensions, in Inches

Point	Span	Radius	Crown Thickness	Rise	Over-all Depth
B_2	6.5	30	0.235	0.1775	0.412
B_3	6.5	40	0.347	0.1308	0.4778
B_4	6.5	60	0.453	0.0449	0.4979
B_5	6.5	∞	0.530	0.000	0.530

Note: Breaking load for all of these structures is 600 times the model weight.

What Price Gold?

Unsettled Monetary Conditions Make the Future Obscure

H. D. Keiser

Associate Editor

IN THE last two years the price that the gold miner has received for his product has fluctuated over a wide range in several countries; and what he will obtain for his metal in the near future, even in the next few months, seems to be a question fraught with much uncertainty. The effect that this changing price level has had and may have on the gold-mining industry in the three leading gold-producing countries —South Africa, Canada, and the United States—is briefly considered in the following paragraphs, with the view that the discussion may contribute to a better general understanding of some of the economic problems confronting the producers of the world's major monetary metal.

Two years ago the currencies of the three aforesaid countries were based on a gold standard, and gold was selling in London at its standard value of about 84s. 11½d., or £4.25, a fine ounce. Gold production in each of the countries was at what might then have been described as a normal rate, South Africa averaging about 895,000 oz. for the first six months of 1931; Canada, 212,000 oz.; and the United States, 200,000 oz. In South Africa gold was quoted at its standard value of about £4.25, and in Canada and the United States, with the Canadian dollar about at par, it had a value of about $20.67. Gold miners the world over were enjoying not only the usual advantage of an unlimited demand for their product at an unchanging price level, but also the lower costs of supplies and labor that had developed with the prolongation, nationally and internationally, of adverse economic conditions. In brief, from the gold miner's standpoint, "all was serene." With the suspension of the gold standard by the British Parliament on Sept. 21, 1931, however, an unsettling influence was introduced—an influence that increased in intensity in succeeding months and affected directly or indirectly the gold-mining industry throughout the world.

The following month—Oct. 19, 1931, to be exact—Canada, by a Special Order in Council, prohibited the export of gold, and thereby removed the currency of the Dominion from the gold standard. On Dec. 28, 1932, by an order of the Minister of Finance, South Africa departed from the gold standard. And, on April 20, 1933, the United States, by an Executive Order that prohibited "the earmarking for foreign account and the export of gold coin, gold bullion, or gold certificates," went off the gold standard. Consideration of events in each country that led up to the abandonment of the gold standard is not appropriate here, but expression should be given to the view that in each instance protection of financial resources prompted the action.

A record of the monthly average prices of gold in the three countries and in London, and monthly average exchange rates in United States dollars for sterling, the Canadian dollar, and the South African pound, are presented in Table I. A monthly record of gold output appears in Table II. The accompanying production and price curves are based on the data shown in the tables.

Banket ore from the Witwatersrand reefs; the source of South African gold

South Africa

Prior to Sept. 21, 1931, when England went off gold, South African exchange, as indicated in Table I, was 0.25 per cent below sterling exchange. By the end of the month, after about a week of unsteadiness, South African exchange settled to a value that ranged between $4.84 and $4.86; this value continued until South Africa went off gold on Dec. 28, 1932. Toward the close of the following month South Africa currency was linked with sterling by legislative action, and South Africa exchange has since then moved uniformly with and slightly below sterling exchange.

Until the gold standard was abandoned, South African producers sold their output to the South African Reserve Bank at a fixed rate based on the standard value of gold. This selling procedure has continued, with the rate of payment increasing, of course, as the South African gold quotation advanced. This quotation, as shown in Table I, is uniformly and slightly below the London gold quotation, for the reason mentioned in the preceding paragraph.

The increased price of gold that has prevailed on the Witwatersrand since Dec. 28, 1932, seems to have had two major results: (1) It brought about the adoption of a plan by the gold-mining companies whereby part of the premium on gold would be applied to the mining of low-grade ore. Production statistics in Table II reveal that gold output of South Africa in the first six months of 1933 totaled 5,559,479 oz., as compared with 5,700,451 oz. in the first half of 1932. The falling off in output of about 141,000 oz. this year is said to be attributable to the mining of low-grade ore. (2) It has brought on the industry new taxation that is reported to insure to the government more than 70 per cent of the total profit resulting from the premium on gold. The proposals for the new taxation legislation, estimated to yield £6,000,000, were made by N. C. Havenga, Minister of Finance, on May 30, 1933, in his budget speech in the South African House of Assembly. These proposals, in a revised form, were adopted by the South African Parliament on June 22. The legislation has aroused much adverse comment on the part of the Transvaal Chamber of Mines and many members of the South African gold-mining industry.

Canada

Canada's announcement of a gold embargo on Oct. 19, 1931, which removed the currency of the Dominion from a gold basis, was accompanied, as shown in Table I, by a sharp decline in Canadian exchange and a proportional in-

crease in the Ottawa gold quotation. This indirectly proportional relation between the Ottawa gold quotation and the value of the Canadian dollar in terms of the United States dollar continued until the United States went off gold on April 20, 1933. After this date the Ottawa gold quotation was based on the price of gold in London, the Ottawa quotation being, in effect, the London quotation converted into Canadian dollars at prevailing exchange rates.

Gold producers in Canada sell their output to the Royal Canadian Mint at Ottawa. Prior to April 20, 1933, the Federal Department of Finance, at the mint, paid for the gold in Canadian dollars, reimbursing producers by an amount equivalent to the exchange premium on United States dollars. This premium, per ounce of gold, is represented by the difference between $20.67, the United States gold quotation, and the Ottawa gold quotation shown in Table I. Since the United States went off gold, the mint has been selling the Canadian gold output in London, the sterling payment received in that market being converted into United States dollars, which are then, in turn, converted into Canadian dollars for settlement with the Canadian producer. This procedure resulted last month in an average premium of about 50 per cent accruing to the gold miner.

Gold production in Canada, as shown in Table II and the accompanying curves, has had a general upward trend until this year, when the mining of low-grade ore, under a higher price for the metal, is said to have been responsible for a decreased output. Taxation to which Canadian gold producers are subject seems to have been kept within what, compared with the new South African tax legislation, might be termed moderate limits. Canadian producers, according to *The Northern Miner* of May 18, 1933, are paying in direct taxation about a 16½ per cent levy on net profits, excluding any allowance for depletion. One-sixth of the increase in the price of gold is said to go to the payment of direct taxes.

Canada seems to have made the most of the gold situation of the last two years. Marketing of the metal has been such that producers have obtained at all times the best price possible for their output; low-grade ore has been mined by the larger companies as the price of the metal increased; a generally moderate taxation policy has been pursued; the gold-mining industry has expanded; and capital for the financing of gold-mining enterprises has been attracted from outside sources.

United States

If the much-condensed presentation employed in the preceding paragraphs is followed in describing the position of the gold producer in the United States, only a few facts need be mentioned. Prior to the establishment of the gold embargo on April 20, 1933, his product was sold to the United States Mint at the rate of $20.67 per fine ounce, and, with the country on a gold standard, this price was then the maximum obtainable for his product.

Since the country went off gold, and prior to July 27 when a new ruling on the export of ore and concentrate was announced, the gold producer has, by government ruling, been prohibited from exporting or accumulating gold; his output had to be sold without delay to the mint on the basis of $20.67 per fine ounce. Denied an opportunity to

Gold production and price curves for the three leading gold-producing countries

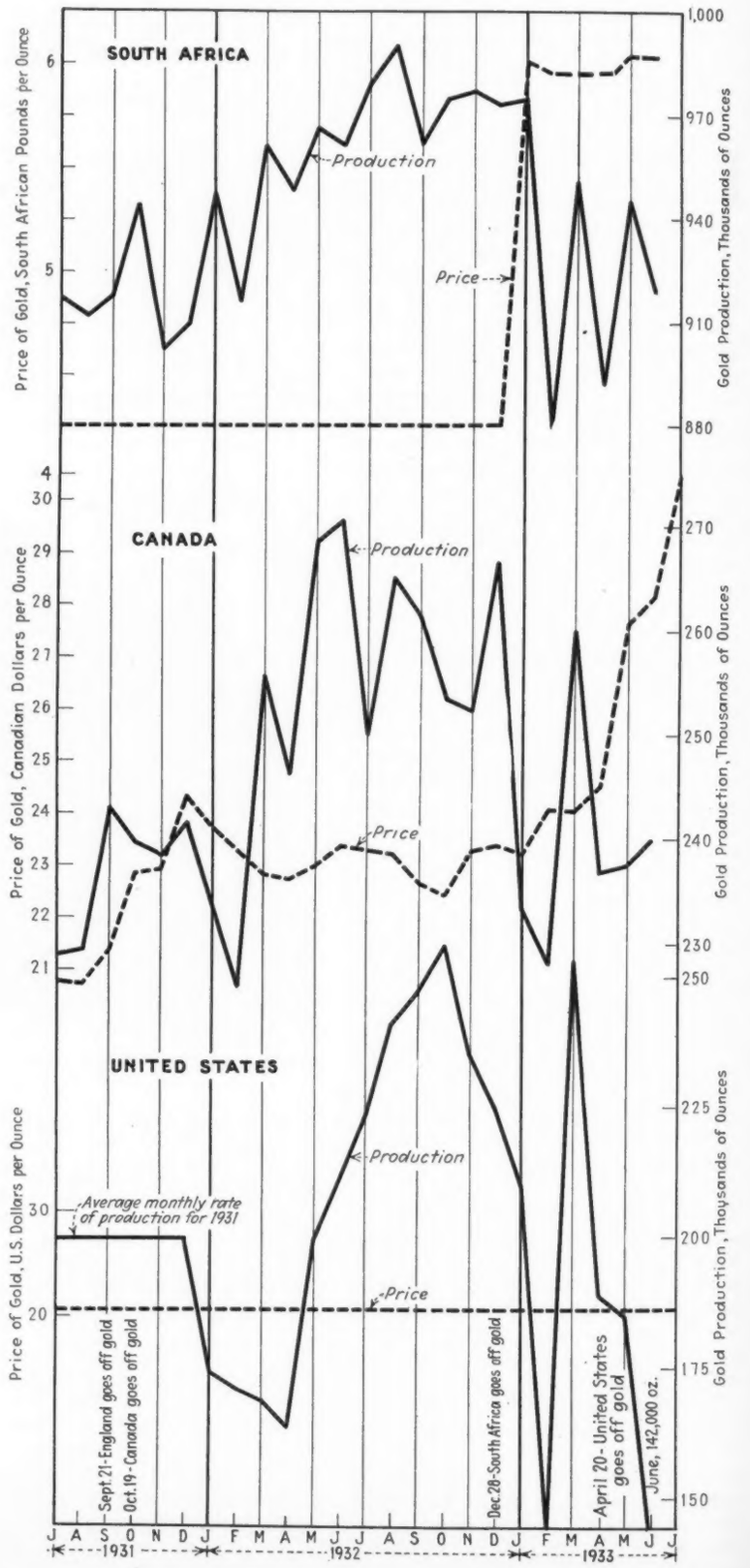

SOUTH AFRICA
Production
Price
Price of Gold, South African Pounds per Ounce
Gold Production, Thousands of Ounces
CANADA
Production
Price
Price of Gold, Canadian Dollars per Ounce
Gold Production, Thousands of Ounces
UNITED STATES
Production
Average monthly rate of production for 1931
Price
Price of Gold, U.S. Dollars per Ounce
Gold Production, Thousands of Ounces
Sept. 21-England goes off gold
Oct. 19-Canada goes off gold
Dec. 28-South Africa goes off gold
April 20-United States goes off gold
June, 142,000 oz.
J A S O N D J F M A M J J A S O N D J F M A M J J
1931
1932
1933

Table I—Monthly Average Prices of Gold and Exchange Rates

	London Gold Quotation, Pounds Sterling	Ottawa Gold Quotation, Canadian Dollars	South African Gold Quotation, South African Pounds	United States. Gold Quotation, U. S. Dollars	Sterling Exchange, U. S. Dollars	Canadian Exchange, U. S. Dollars	South African Exchange, U. S. Dollars
1931							
July....	(a) 4.25	(b) 20.74	(a) 4.25	(b) 20.67	(c) 4.85	(d) 0.9966	(e) 4.84
Aug....	4.25	20.73	4.25	20.67	4.85	0.9969	4.84
Sept....	4.56	20.83	4 25	20.67	4.51	0.9925	4.50
Oct.....	5.31	22.92	4.25	20.67	3.88	0.8910	4.85
Nov....	5.53	22.95	4.25	20.67	3.71	0.8899	4.85
Dec.....	6.10	24.24	4.25	20.67	3.37	0.8271	4.85
1932							
Jan.....	6.02	23.74	4.25	20.67	3.43	0.8513	4.85
Feb.....	5.98	23.30	4.25	20.67	3.45	0.8729	4.85
March..	5.71	22.85	4.25	20.67	3.63	0.8945	4.85
April....	5.51	22.76	4.25	20.67	3.75	0.8988	4.85
May....	5.64	23.06	4.25	20.67	3.67	0.8844	4.85
June....	5.67	23.41	4.25	20.67	3.64	0.8674	4.85
July....	5.80	23.34	4.25	20.67	3.55	0.8707	4.85
Aug....	5.93	23.24	4.25	20.67	3.47	0.8755	4.85
Sept....	5.93	22.68	4.25	20.67	3.47	0.9026	4.85
Oct.....	6.07	22.48	4.25	20.67	3.40	0.9123	4.85
Nov....	6.29	23.30	4.25	20.67	3.27	0.8730	4.85
Dec.....	6.29	23.44	4.25	20.67	3.28	0.8660	4.85
1933							
Jan.....	6.13	23.26	(f) 6.00	20.67	3.36	0.8746	3.41
Feb.....	6.03	24.08	(f) 5.95	20.67	3.42	0.8351	3.39
March..	6.02	24.07	(f) 5.95	20.67	3.43	0.8352	3.40
April...	6.03	24.58	(f) 5.95	20.67	3.58	0.8472	3.54
May....	6.17	27.63	(f) 6.00	20.67	3.93	0.8759	3.89
June....	6.11	28.19	(f) 6.00	20.67	4.13	0.8989	4.09
July....	6.12	(g) 30.78	(h)	20.67	4.65	0.9447	4.59

(a) Standard value, £4.24773
(b) Standard value, $20.671834
(c) Par: $4.8665
(d) Par: $1.00. Averages from Federal Reserve Bulletin.
(e) Par: $4.8665. Averages for 1931-32 based on data furnished by the Standard Bank of South Africa; 1933 averages from the Federal Reserve Bulletin.
(f) Estimate of the Transvaal Chamber of Mines.
(g) Preliminary figure subject to revision.
(h) Not available.

obtain an increased price for his metal, little incentive has been given the gold miner to increase his output. That a downward trend in gold production resulted from this policy of the United States seems to be indicated by the statistics that appear in Table II.

The following conclusions are presented:

1. Throughout the period of unsettlement that has characterized the international monetary system in the last two years, Canada seems to have been most keenly alive to the opportunities that the situation afforded, benefiting therefrom to a much greater degree than any other country. Political upheaval, accompanied by the adoption of a questionable tax policy, seems to have been the lot of South Africa. Isolation seems to have been the objective of the United States, particularly prior to the government ruling of July 27.

2. That another factor—uncertainty concerning the future position and value of gold as a monetary metal—is also influencing the present policies of the gold-mining industry throughout the world would seem to be an inescapable deduction. The uncertainty is undoubtedly tending to delay the adoption of extended plans by many mining companies, particularly those operating on a large scale. Also, this factor, in addition to the mining of low-grade ore, has undoubtedly been partly instrumental in bringing about decreased production in recent months.

Table II—
Monthly Record of Gold Production

(Fine Ounces)

	South Africa (a)	Canada (b)	United States (c)
1931			
July.....	917,139	228,878	(d) 199,656
Aug.....	912,324	229,216	(d) 199,656
Sept.....	918,211	243,109	(d) 199,656
Oct.....	944,532	239,691	(d) 199,656
Nov.....	903,315	238,354	(d) 199,656
Dec.....	909,873	241,643	(d) 199,656
1932			
Jan.....	947,511	233,826	174,000
Feb.....	916,000	225,891	171,000
March.....	961,558	255,675	169,000
April.....	948,047	246,359	164,000
May.....	966,060	268,543	199,000
June.....	961,275	270,526	211,000
July.....	980,464	250,394	223,000
Aug.....	990,471	265,090	241,000
Sept.....	962,090	261,538	246,000
Oct.....	975,114	253,503	255,000
Nov.....	976,716	252,517	235,000
Dec.....	973,228	266,719	225,000
1933			
Jan.....	974,851	233,456	210,000
Feb.....	879,287	228,224	147,000
March.....	950,944	260,154	252,000
April.....	891,534	237,017	189,000
May.....	944,230	237,661	185,000
June.....	(e) 918,633	(e) 240,000	142,000

(a) Department of Mines and Industries, Union of South Africa.
(b) Dominion Bureau of Statistics, except as noted
(c) American Bureau of Metal Statistics.
(d) Average monthly output in 1931; monthly statistics not available.
(e) Preliminary figure subject to revision.

3. The outlook for gold mining throughout the world varies from bright to decidedly dull, depending largely to what ends government has utilized the industry. Until the monetary position of gold is again stabilized on an international basis, the gold miner will apparently continue to be confronted with a common but all-important problem shared by his colleagues in the other branches of mining—namely, what price will his future output bring when it is available for sale. Not until the aforesaid stabilization is effected will the serenity typified by the first half of 1931 prevail again in the gold-mining industry.

Excerpts from a discussion of the future of gold, presented by P. M. Anderson, at the annual meeting of Union Corporation, Ltd., on May 19, 1933, follow:

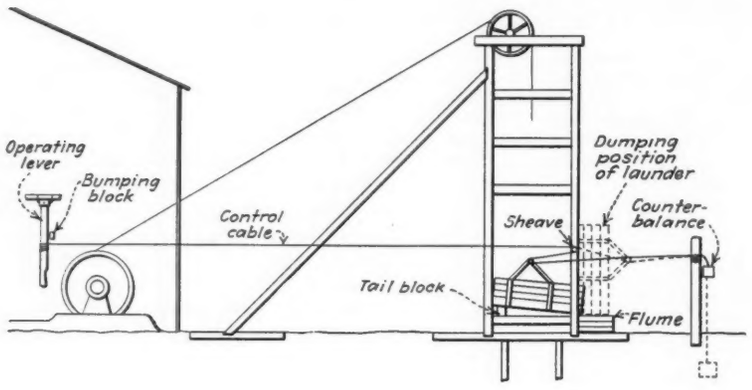
"In a gold-standard monetary system, gold and the currencies based upon it normally perform a dual function: they are at one and the same time measures of value and means of payment. In addition, they can be used as stores of wealth; but in normal times and among all except the most primitive peoples they are hardly ever so used, for the simple reason that there are many other forms of wealth which produce an economic return, while gold or currency, if stored away, is a barren asset. This only holds good, however, for so long as the purchasing power of gold (and of the currencies based upon it) remains fairly stable. One of the great problems before the world today is to devise an international monetary system which will command the general esteem which gold commands and which at the same time will give us a really stable measure of value.

"It is too early to say exactly what the new system will be, but this much can be said: if, under present conditions, it is to obtain wide international acceptance, it must be based on gold.

"Thus, if a satisfactory international monetary system is to be reestablished, it would seem desirable to provide for wide acceptance by basing the system on gold; to provide for stability in purchasing power (and therefore in the level of international prices) by insisting upon adequate safeguards and economies; and to provide for a bearable level of internal prices by adopting new and lower gold parities for the various currencies as and when they return to gold. This is obviously not a simple program, but in my opinion it is an absolutely necessary one if there is to be made available for international trade a satisfactory monetary system. Whether, when, and to what extent this program will be adopted depends upon the pressure of events and upon the wisdom of national leaders."

In addition to the sources mentioned in the footnotes to the tables that accompany this article, acknowledgment is made to the following agencies for much of the information presented: the South African Legation, Washington, D. C.; Division of Research and Statistics, Federal Reserve Board, Washington, D. C.; Ontario Department of Mines; Ontario Mining Association; Mines Branch, Department of Mines, Canada.

Discharge Launder for Valve Bailer



ACID MINE WATER at the Good Hope mine, Gunnison County, Colo., was bailed by valve bucket to avoid the expense of an acid-proof pump and water column, writes W. P. Crawford, of Bisbee, Ariz. Bailing was done on the graveyard shift and operation of the discharge launder from the hoist room removed the need for a top man.

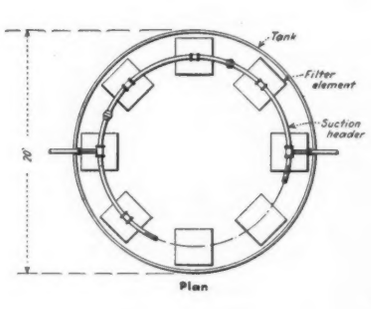
Scrap metal at the mine was used to construct the launder. The bottom of the box was made of 4-in. lumber, and the sides and end were of 3-in. material, fastened by outside cleats and "hog" rods. The box was calked and tarred to prevent leakage. Width of the box was greater than the lower diameter of the valve bucket, to allow the valve stem to trip on the bottom of the box. The hinges were made of flat iron, with a 1-in. round steel rod for a hinge pin, and were placed so that the box, when in an upright position, would clear the cage for day-shift hoisting. An inverted V-shaped bracket, made from flat iron, was bolted to one side of the launder, and the apex of the "V" extended above the top of the box. The control cable from the hoist room and the counterbalance cable were fastened to this bracket. From the hoist room the cable passed over an open-grooved sheave attached to the headframe. A wooden block nailed above the sheave prevented the cable from jumping out of the groove. An operating lever, made from 2x6-in. plank and suspended from a roof stringer above the hoist, was kept in proper position by a wooden bumping block.

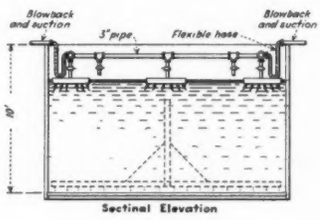
The end of the launder, in the discharge position, was supported by a removable tail block high enough to give a 12-in. fall. After discharging, the valve bucket was hoisted above the launder, and a sharp pull on the operating lever raised the box. The counterbalance carried it to an upright position and held it clear of the shaft. To lower the launder, the lever was pulled sharply, and the box dropped from its own weight. No slack should be allowed in the control cable.

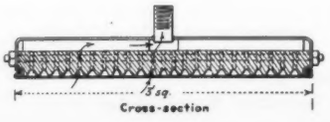
New Dewatering and Filtering Machine

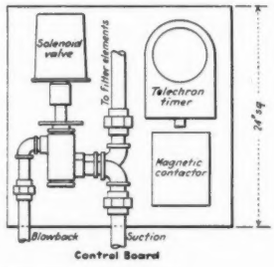
FOR A LONG TIME a need has existed for an inexpensive dewatering machine, writes F. C. Torkelson, designing engineer, Utah Sulphur Industries, Sulphurdale, Utah. The device shown in the accompanying illustration is low in first cost, and the operating expense is slight. It can be made in any mill machine shop without the use of special tools, and control equipment is an assemblage of standard units.

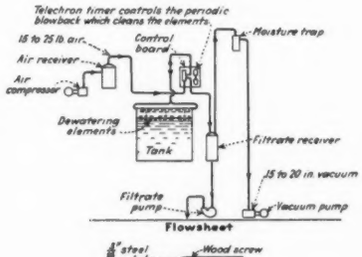
The new feature of the machine is that it floats on the material to be dewatered. This insures constant dewatering regardless of the water level in the tank. The device has a useful place in plants where withdrawal of thickened sludge is periodic and rapid, causing the water level to vary greatly.

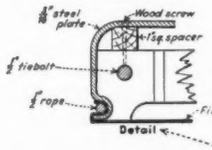


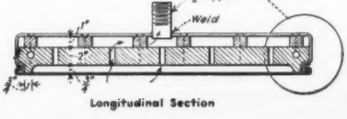












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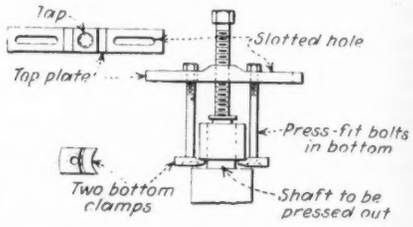
Emergency Pipe Clamp

NEED to plug a 10-in. pipe, not threaded on the end, used on a water system under pressure, prompted the device illustrated, which was satisfactory for the purpose. In fact, the emergency clamp proved so efficient that it was used permanently on the end of the line.

After making the clamp as illustrated, place it in the pipe, allowing enough of the top end of the bolt to project out of the pipe so that the cap and cap nut can be set in place. Tighten up as much as possible on the square end of



the bolt after it is in place in the pipe; then set the cap in place and tighten the nut. A gasket should be placed between the end of the pipe and the cap, also under the cap nut, to prevent leakage at these points. As pressure on the cap continues to force the clamp to the side of the pipe, the clamp will be rigid and secure at all times.

Lahontan Quicksilver

Studies of Deposits Found Indicate Other Possibilities

C. N. Schuette

QUICKSILVER occurrences are widely distributed over the western half of the Great Basin, extending from southeastern California, as at Coso, through Nevada and into Oregon on the eastern side of the Cascade and Sierra Nevada ranges. West of these ranges lies a parallel belt of quicksilver occurrences, chiefly in the Franciscan rocks of California and Oregon. In both these belts the quicksilver occurrences are so widespread and frequent that regional conditions must have governed their deposition, and an intra-regional relationship may exist between them.

The western belt is notable for its many large quicksilver mines exhibiting a definite type of orebody characterized by intensely shattered receptacle rocks, a geologic structure favorable to concentrated deposition, and great quantities of ore that are the result of intense or long-continued mineralization.

The eastern, or Great Basin, belt of quicksilver deposits is characterized by shallower occurrences, and the total quantity of ore in any one of them has, in general, been much less.

Quicksilver deposits of both belts lie along major faults in the earth's crust. Those of the Great Basin belt lie along the faults bordering the long narrow blocks of the typical Great Basin system of mountain structure.

Lake Lahontan lies in the northwestern part of the Great Basin, and its geological history is given at length in I. C. Russell's "Monograph XI" of the United States Geological Survey publications. This Quaternary lake was bounded largely by the upturned edges of characteristically long and narrow orographic blocks. The shore lines then, where the marginal lake beds were deposited, lie along these great lines of fracturing and faulting.

Russell called attention to the relative scarcity of "hillside" springs and the abundance of "fissure" springs (he mapped 103 of them) in this region. These latter, mineralized hot springs, almost invariably occur along the lines of displacement on the ancient lake shores.

Many of the present hot springs exhale sulphureted hydrogen and deposit calcareous tufa. At others siliceous sinter is precipitated as the water cools. Many such deposits made by springs now extinct occur along the shore faults. Most of these are calcareous tufa precipitated about sublacustral or underwater springs. Others are siliceous sinter (opalite) deposited by subaerial or surface springs.

For the reason that the shore lines of the lake lie along the faults on which both the ore occurrences and the hot springs are found, the ore deposit is often in, or associated with, the sinters of former hot springs buried in the lake beds near the ancient shore.

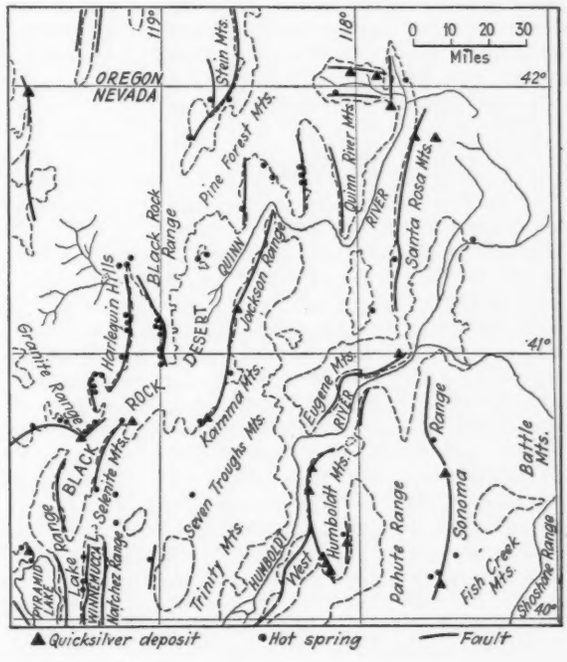


Fig. 1 — Map of northern part of Lake Lahontan. High-water stage, as marked by ancient shore lines.

Fig. 1 shows the northern part of Lake Lahontan at its high-water stage as marked by ancient shore lines, together with the shore faults, hot springs, and quicksilver deposits. Here is a region in which intelligent prospecting for cinnabar-bearing hot-spring sinters might add materially to known resources of quicksilver.

Two Mines

Two quicksilver mines in typical hot-spring sinter deposits have been developed and exploited sufficiently to afford an understanding of how they were formed. These are Opalite and Bretz, the two most northern deposits indicated on the map, which are being operated by the Bradley Mining Company. Both Opalite and Bretz lie on east-west faults at the northern rim of a lake basin. Both deposits are in the sinters formed by extinct hot springs. The mineralizing solutions in each case were merely a phase, and apparently a late phase, in the sinter deposition.

This basin, at Lat. 42 N. and Long. 118 W., is not shown as a part of Lake Lahontan on Russell's map. The evidence of extensive lake beds and post-lake faulting on its northern rim lead me to believe that it may have been a part of Lake Lahontan raised to its present position some 1,000 ft. higher by post-Lahontan faulting. Determination of this would be interesting, as literally miles of lake beds are exposed on the northern shore which contain fossil trees up to 18 in. in diameter, and these may throw additional light on the much-discussed question of climatic conditions during Lahontan times as given in "Publication 352" of the Carnegie Institution of Washington.

The nearest railroad point to these two mines is Winnemucca, Nev., from which town an excellent road runs north some 76.6 miles to McDermitt, on the Oregon-Nevada border. From here a good road runs a little north of west 11.5 miles to Bretz and 20.2 miles to Opalite.

Opalite was discovered in 1924 and developed in 1925-26, and its reduction plant was finished late in 1926. To the end of 1932 the mine had produced 10,027 flasks of quicksilver from 123,634 tons of ore of an average grade of 6.15 lb. per ton on recovery. The glory-hole method of mining has been described by me in the United States Bureau of Mines Bulletin 335.

Bretz was discovered in 1917, but not exploited until the discovery of high-grade ore in 1931, when the Bradley Mining Company took over the property and mined ore with a gas shovel from open cuts. The ore mined was treated at the Opalite plant. To the end of 1932 the mine had produced 2,629 flasks of quicksilver from 9,177 tons of ore of an average grade of 21.8 lb. per ton on recovery. This production was made in the latter part of 1931, as only development work was in progress in 1932.

The Opalite Deposit

At Opalite, hot springs deposited a lens-shaped mound of siliceous sinter (opalite) in the basin on the shore of the lake. This was subaerial deposition. Different parts of this deposit show differing characteristics such as vugginess, banding, massive facies, and the like, but the process of formation must have been fairly continuous, as no intercalated sediments are apparent.

After the opalite lens had formed approximately as shown in the cross-section, Fig. 2A, the region underwent folding. The lens of opalite happened to be on the top of an anticlinal part of the fold. This caused faulting of the lens in the thick western part while the thinner eastern part was broken in the manner indicated in Fig. 2B. The anticlinal folding of the Lower Lake Beds which underlie the opalite lens can be seen ¼ mile west of the mine, exposed by erosion, as well as in the mine workings.

Actually, of course, the soft underlying lake beds did not break in open fractures, as indicated in Fig. 2B, but were squeezed into pressure folds as shown in Fig. 2C. Such pressure folds can be seen in several parts of the mine workings. Upon completion of the folding movement which fractured the opalite, the surface was covered and the fractures were filled with broken fragments of the opalite. A renewed flow of silica-bearing solutions followed soon after the folding, and this phase of the siliceous spring activity was mineral bearing as well. As these mineralized solutions came up to the surface through the V-shaped, detritus-filled fractures, they re-cemented the breccia by depositing silica and cinnabar in the interstices, and so formed the orebody being mined today.

After the ore deposition, other beds, now called the Upper Lake Beds, were deposited over the opalite, and then a slight recurrent folding action caused renewed but moderate fracturing of the opalite, and this seems to have been largely along the lines of the previous fractures. These new, narrow fractures filled from above with lake-bed material and are visible in the mine pit today.

Cinnabar and silica were deposited together. Even minus 200-mesh particles when examined under the microscope show that the cinnabar is still surrounded by silica. This, I think, accounts for the darkening of the ore on exposure to the sun. The silica turns dark, like glass bottles in the desert sun, and obscures the red color of the cinnabar. I have never seen any cinnabar turn dark on exposure to sunlight (see "The Red, Yellow and Black Quicksilver Minerals." *Min. & Met.* July, 1929; p. 329).

Secondary minerals of quicksilver (oxychlorides) are found in or near the post-mineral fractures where humus surface acids could penetrate to effect the change.

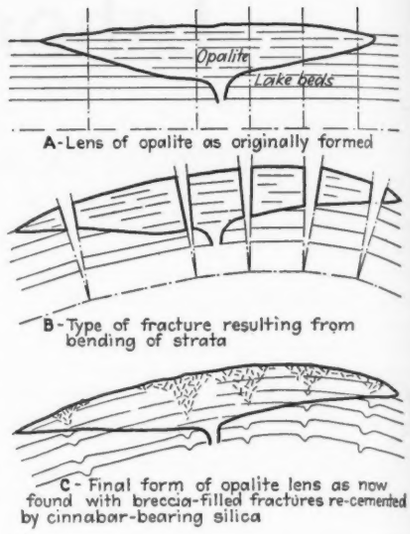

Opalite
Lake beds
A-Lens of opalite as originally formed
B-Type of fracture resulting from bending of strata
C- Final form of opalite lens as now found with breccia-filled fractures re-cemented by cinnabar-bearing silica

Fig. 2—Stages in formation of deposit at Opalite

Fig. 3 shows a map and sections of the Opalite mine. The ore outcropped in the area of the large pit and also around the two small pits to the west. The main tunnel level is approximately at 5,000 ft. elevation, 80 to 100 ft. below the outcrop. Sublevels are about 40 ft. above the tunnel. The lowest level of the winze is 100 ft. below the tunnel level. Besides these workings, three adits were driven north from the pit and two shorter ones north from the surface in the western part of the mine. Besides raises from the tunnel and sublevel to the surface, a number of shafts and pits were sunk in the course of exploration.

The main post-mineral fractures through the orebody are shown in serrated lines. As they follow the pre-mineral lines of fracturing, they serve as ore guides. These surface-filled fractures are distinctly more numerous in the eastern part of the opalite lens where the ore was most abundant. On the west, faulting occurred, making only narrow fractures through which the mineralizing solutions were quickly conducted to surface, where they were dissipated.

Wide-open, breccia-filled fractures such as were formed at Sections E and F, the zone of greatest mineralization (mineralization is indicated by dots), formed funnels in which rising solutions slowed down and cooled, and some concentration of the primary mineralization took place. The sections show the general lens-shaped character of the opalite deposit. Toward both the east and west the lens thins out. One of the actual spring founts was cut by the main tunnel as shown in Section F.

The dip of the lake-bed strata is indicated on the sections by the shading, excepting that of the fossil wood bed

West benches of Bretz mine. Light-colored rock in center is calcareous sinter. Dashed line incloses surficial silica flow. Indurated tuff beds beyond fault, in upper left.

which is shown by vertical cross hatching. It has the same flat dip as the other Upper Lake Beds. The Lower Lake Beds under the opalite have steeper dips, and on Section C the winze workings are shown penetrating still older highly silicified lake beds. The latter were first thought to be an igneous rock (C. N. Schuette, "Occurrence of Quicksilver Orebodies." *Trans.* A.I.M.E., Vol. 96, p. 445), but microscopic examination shows that their appearance is deceptive and that they are undoubtedly of sedimentary origin, though locally known as the "basalt."

The winze was put down in a fault (see plan), and some ore is found in the fractured rock adjacent to it. Thin streaks of "paint ore" are found in the Lower Lake Beds under the opalite, especially where the ground was broken a bit in the pressure folds as shown in Section C. In general, the fault planes and lake beds offered too little interstitial space to permit of sufficient deposition to form minable ore.

Opalite mine has reserves grading from 15 to 3 lb. per ton, and its ultimate life and output depend largely on the price of quicksilver.

At Bretz

If the fossil-wood strata at Opalite and Bretz were laid down at the same time—and this is probable—the Bretz deposit lies at a higher geologic horizon than Opalite. Opalite was formed before these deposits were laid down in a low-water stage of the lake in accord with the subaerial deposition of the silica.

At Bretz, the fossil-wood strata are mainly below and extend up to the ore-bearing strata, and the mineralization occurred during or after a high-water stage of the lake following the low-water stage during which Opalite was formed. Sublacustral hot springs deposited an irregular lens of calcareous sinter near the shore. Mounds of calcareous tufa were built up around the spring vents on the top of this deposit and added to its irregularity of outline. The bottom of the deposit is fairly dense rock, but near the top it shows an open, spongy, or reticulated structure. Lake beds were being deposited at the same time and apparently built up to about the same level as the top of the calcareous sinter.

Fig. 4 shows a plan and sections of the Bretz mine. Toward the north an east-west fault delineates the ancient shore line. North of the fault are old, indurated tuff beds dipping some 30 deg. south. The lake beds lie against these, dipping south at gentler angles and showing the typical sag dips of lake beds deposited near shore. The calcareous sinter has been found extending 500 to 600 ft. east and west (from Section C to F), with the southern border very irregular.

On both the east and west ends of Carnation claim, creek beds run south. Between them the lake beds form a mound covered with desert wash as shown by the contour lines and sections. Ore was first mined on the west side of this mound in three benches at 4,980, 5,000 and 5,015 ft. elevations respectively. Then ore was mined on the eastern side of the mound at 5,000- and 5,015-ft. elevations. The lower extension of the west orebody was explored by an adit driven on the side line of Carnation and Rattlesnake claims. Then the area between the west and east benches was explored by a shaft sunk to Elevation 4,990 and levels at this depth. Raises were put up and winzes and drill holes were put down from this level.

Inasmuch as both the calcareous sinter and the ore had been found in both the east and west benches at approximately the same elevation and relative position, it was thought that both might extend across the area between them much as they showed in the pits. The hot-spring action that deposited the calcareous sinter was thought to have brought up the ore also, as this sinter contained cinnabar on its southern edge.

This was a beautiful theory, soon killed by ugly facts exposed in the shaft and 4,990 level. Ribs of siliceous sinter were found, but the calcareous sinter proved its irregularity by being hard to find. Only the northwest and north extensions of the 4,990-ft. level found it as indicated on Sections C and D. The siliceous sinter, however, carried cinnabar, and some of it was high-grade. This caused a re-examination of siliceous rock noted elsewhere around the mine. The reconstructed picture is as follows:

A later phase of the hot-springs activity after deposition of the calcareous sinter, and probably following renewed faulting, was siliceous. These siliceous waters deposited their silica (indicated by vertical cross hatching in the sections of Fig. 4) on the surface over the calcareous sinter in crustal sheets and in nodules and other typical "geyser-basin" forms. The areas of this surficial silica development are inclosed in dashed lines on the plan of Fig. 4, and also on accompanying halftones. These siliceous waters, flowing into the lake, where lake beds were still being deposited, formed silicified strata of the lake beds. Two of these, about 18 in. apart vertically and 4 to 6 in. thick, are particularly well developed, are clearly visible in the eastern face of the west benches, and mark the upper limit of the ore. They are indicated in Sections C, D, and E. Ribs of siliceous rock found at various places in the mine workings were also formed at this time.

Apparently toward the end of this siliceous phase of hot-spring activity, the cinnabar was deposited. Some deposition took place from waters circulating in the reticulated masses of calcareous sinter, but most of it occurred in the sand, gravel, and clay strata of the lake beds out under the dense silicified strata near the surface, which acted as an impervious cap rock to prevent the escape and dilution of the mineralizing solutions. The presence of this cap rock accounts for the concentration of the primary mineralization that resulted in the formation of the high-grade orebodies as found.

The distribution of the surface silica indicates two spring vents and two directions of flow from these as indicated on the map Fig. 4.

Inasmuch as ore deposition was associated with the siliceous phase of the spring activity, the surface silica constitutes a rough guide to underground exploration. Also, projections of the calcareous sinter toward the south seemed to favor the formation of the orebodies mined in the east and west benches, probably by directing the flow of mineralizing solutions along their underside out into the pervious lake beds under the cap-rock layer. Another such southward projection of the calcareous sinter occurred at Section D.

From such observations it was predicted that the area between the west benches and section line D on the map was favorable for the formation of a high-grade orebody. At this time the

Opalite pit from south rim. In center, a scraper is moving ore to glory holes from right corner.

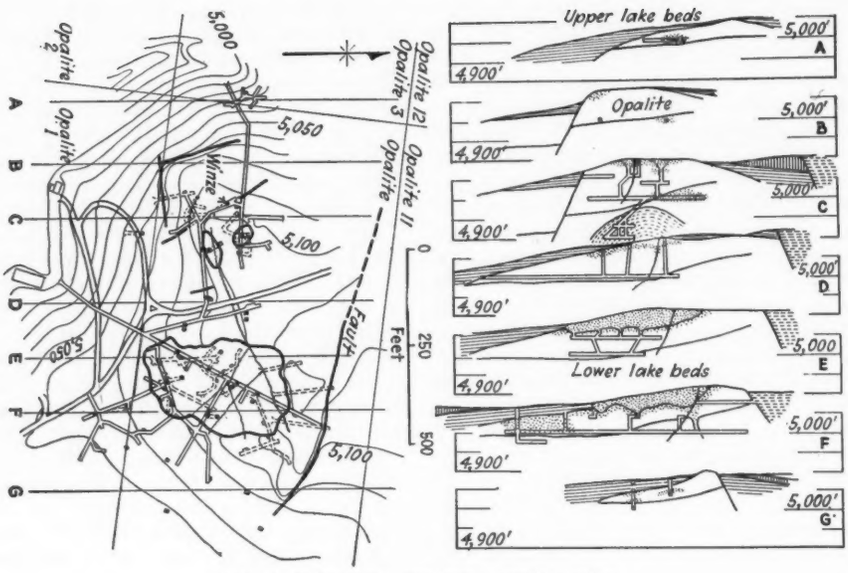


Fig. 3—Plan and sections, Opalite mine.

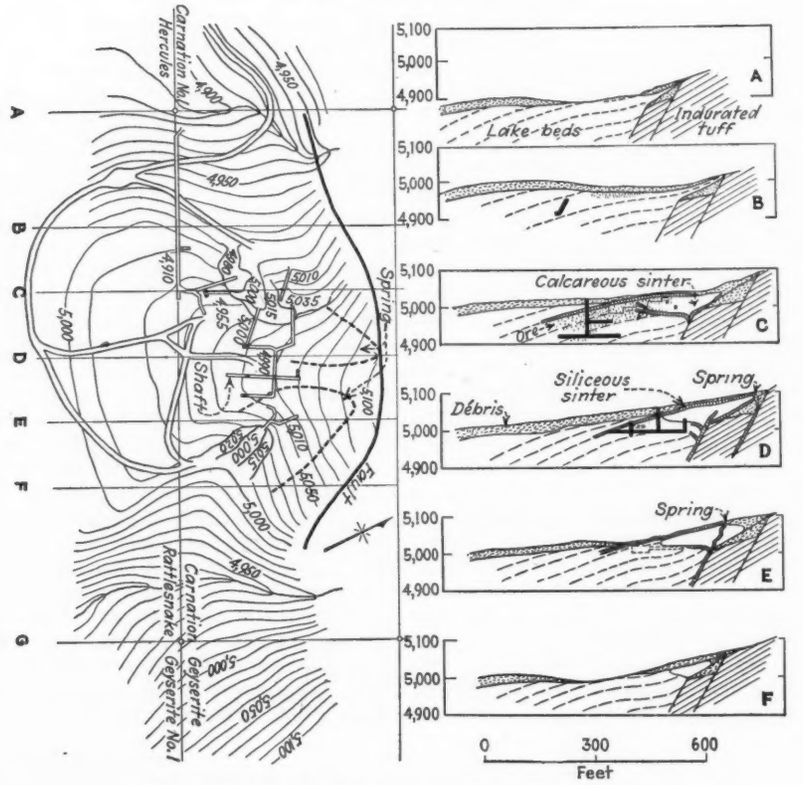


Fig. 4—Plan and sections, Bretz quicksilver mine.

eastern face of the bench assayed only 5 lb. per ton, and the grade had been dropping off rapidly as the face advanced toward the east. Muck samples from the raise put up from the southwest end of the 4,990 ft. level (near section line D) averaged only 7 lb. per ton. To test this prediction of a high-grade orebody a tunnel was driven from the 5,000-ft. bench to this raise. The distance was 113 ft., and muck samples from each round assayed as given in the table.

The sample from 74 to 78 ft. is missing. The weighted average of the samples for the other 109 ft. of tunnel is 24.6 lb. of quicksilver per ton. Thus the theory of ore deposition as outlined has proved its soundness as a working theory for finding ore.

Ore Grades in Prospect Tunnel

Distance Ft.	Assay Lb. Hg/Ton	Distance Ft.	Assay Lb. Hg/Ton
0- 3	1.9	59- 63	59.6
3- 7	5.8	63- 67	72.0
7-12	10.6	67- 70	53.6
12-17	3.4	70- 74	39.2
17-22	2.6	78- 82	23.2
22-27	17.8	82- 85	22.8
27-32	6.2	85- 89	79.0
32-36	7.4	89- 92	50.8
36-40	9.4	92- 96	79.6
40-44	13.4	96- 99	36.4
44-48	10.3	99-103	12.8
48-52	8.4	103-107	18.8
52-56	10.2	107-110	17.4
56-59	37.2	110-113	7.2

No ore was treated in 1932, because stocks of unsold quicksilver were on hand and the price declined. Development was carried on and substantial reserves were proven. The ore may be treated at the Opalite plant, as in former operation, or a plant may be built at Bretz. Decision of these matters will probably be delayed until present uncertainties of price, tariff, depreciated foreign currencies, and the like have been cleared up.

Both orebodies are in hot-spring sinters in the lake beds on the fault lines delineating the ancient shore. The hard outcrop of Opalite was a conspicuous landmark for ages, but discovery was delayed until 1924 because this rock turned dark on exposure to the sun, though almost any freshly broken piece of rock over an area some 350 by 200 ft. showed cinnabar.

Bretz was discovered in 1917, but only assessment work was done until the high-grade ore was found in the course of this work in 1931. A little luck in starting a 30-ft. shaft in the right place would have found it before then.

The average grade of ore at Bretz is much higher than at Opalite because structural conditions there favored a concentration of the primary deposition (C. N. Schuette; "Occurrence of Quicksilver Orebodies." *Trans.* A.I.M.E., Vol. 96, p. 404-405) under a cap rock, whereas at Opalite the less favorable structure of an uncapped breccia (compare Montebuono mine, *ibid* p. 473-474) served as a receptacle rock for the ore. In both, the ore solutions were a late or recurrent phase of the hot-spring activity, as the original opalite lens formed and was fractured before renewed activity of the spring brought up more silica and the cinnabar. At Bretz, the early spring activity deposited calcareous sinter and a later activity brought up silica and cinnabar.

Both mines have large orebodies close to the surface. A number of 30- to 40-ft. shafts at either, not a difficult task for a pair of prospectors, would have proved a sufficient tonnage of ore to give even a pessimistic engineer something to write a report on. Both mines had enough high-grade ore suitable for retorting to support the prospector pending sale to a "big company."

Thousands of miles of territory, well marked by lake beds, faults, hot springs, and sinter deposits, remain to be explored for similar quicksilver deposits on the shores of Lake Lahontan and other ancient lakes in the western part of the Great Basin. The sinter deposits are harder than the lake beds, and hence outcrop if erosion has been sufficient to expose them. The lake beds are soft, and many gullies have been eroded through them. Cinnabar in such gullies can be found by panning, and study of the lay of the land should enable the prospector to "figure out" where digging might produce results.

TELLURIDES

Problem or Alibi?

W. E. Johnston

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FOR more than thirty years, in various parts of the world, the problem of the metallurgical treatment of telluride gold ores has been vitally important. The ores of the great mining districts of Kalgoorlie, Western Australia; Cripple Creek, in Colorado; and Kirkland Lake, in Ontario, are noted for their telluride content and for the difficult milling problems they present. Millions of dollars have been spent in experimenting to reduce the tailings losses. Thorough search of the literature revealed details regarding the milling methods of these camps, the flowsheets, machinery, grinding costs, special reagents, and roasting and reduction. In no instance did it disclose any information as to tailings loss or the amount of gold in raw tellurides that was soluble in cyanide solution, nor was evidence found as to the existence of gold-bearing tellurides in the tailings.

Tellurides' Bad Reputation

Many writers have reiterated the statement that tellurides are responsible for the metallurgical troubles associated with these ores. One of the most direct instances of this is to be found in Mellor's "Comprehensive Treatise on Inorganic and Theoretical Chemistry," in Volume 11, page 2, where the author says, "Telluride ores do not give up their gold to mercury, to cyanide or to chlorine." Again, a recent book on flotation says that, generally speaking, cyanidation does not extract the gold or silver occurring locked within the pyrite particles and that it achieves only a poor extraction on tellurides, selenides, and sulphides.

A careful search through the publications failed to show that anyone had actually conducted cyanidation tests on either specimen tellurides or those concentrated from an ore. This fact seemed almost unbelievable. For this reason, the problem was attacked with a view to arriving at an answer for the benefit of science and the mill man.

For some time it has been known that tellurides would float, but that they were difficult to concentrate by gravity methods, as, owing to their extreme brittleness, they became finely disseminated and thus were carried off in suspension. To investigate the behavior of raw tellurides occurring in an ore, with cyanide solution, their isolation from other minerals and gangue was necessary. The total telluride content in any of the ores treated was very small. The concentrating table being unsuited for work entailing such a high ratio of concentration, flotation was employed.

Table I—Results of Cyanidation Tests

Product Tested—Telluride concentrate from a Kirkland Lake ore

Analysis
Gold, 8.65%
Silver, 0.24%
Tellurium, 34.30%

Time of Treatment, Hr.	Gold in Heads, %	Gold in Tails, %	Per Cent of Extraction	Condition of Test
4	8.65	5.59	35.3	No lime
24	8.65	3.82	55.8	No lime
48	8.65	3.71	57.1	No lime
72	8.65	2.74	68.3	No lime
96	8.65	2.27	73.7	No lime
1	8.65	2.98	65.6	Lime added
4	8.65	1.89	79.1	Lime added
8	8.65	0.97	88.7	Lime added
12	8.65	0.39	95.4	Lime added
24	8.65	9.22	97.4	Lime added
48	8.65	0.03	99.6	Lime added
96	8.65	0.01	99.8	Lime added

Average size of particle in this concentrate was minus 2,000 mesh.

Table II—Results of Cyanidation Tests

Product Tested—Telluride concentrate from another mine in Kirkland Lake

Analysis
Gold, 18.36%
Silver, 5.20%
Others,[1] 76.44%

Time of Treatment, Hr.	Gold in Heads, %	Gold in Tails, %	Per Cent of Extraction	Condition of Test
1	18.36	8.58	53.2	Lime added
48	18.36	3.07	83.2	Lime added
96	18.36	2.61	85.7	Lime added
120	18.36	2.06	88.7	Lime added
72	18.36	0.26	98.5	Lime added

[1] See footnote below Table III.

In the flotation tests, a very rich telluride concentrate was produced by simply adding a frothing agent to the cell. Subsequently, it was found, a high-grade concentrate could be made by dry-grinding an ore in the rolls to minus 65 mesh and then adding it directly to the cell. In this operation no frother or collector was required. The problem turned then to recleaning the flotation concentrate. This was made possible by the aid of a specially designed concentrating device. With careful technique, tellurides could be detected in a product if present in the proportion of one part in a million.

At this particular point, however, some quick qualitative method of determining the presence of tellurides in a concentrate became necessary. One was satisfactorily worked out. In short, it consisted in spreading, particle deep, a few particles of the concentrate on a pyrex glass slide and heating them in a bunsen flame. The telluride fused, leaving a characteristic island surrounded by a pool of tellurium oxide. Gold-bearing particles left an island of gold. Base-metal telluride fused to pools of different colors. This last characteristic was pronounced when the slide was reversed in the flame, after the initial fusion. The cause of these various colored lakes was thought to lie in the union of the sulphur in the flame with the base-metal content of the pools. In all probability, a sulphide of the element was formed.

Identification

By such means, tellurides could easily be distinguished from other minerals even in as fine a state as 3,000 mesh and also from one another. Where many tests had to be performed and time was important, the method proved more satisfactory than making a chemical analysis, or setting the particles in bakelite and polishing and examining them microscopically. Examination of the slides was facilitated by the aid of the Leitz illumination system and ultra-opaque objectives for microscopic work.

Telluride concentrates were prepared, in the manner described, from ores and specimens from various localities. Cyanidation tests were conducted, investigating such variables as time, particle size, addition of lime, and the use of special reagents. They were made in bottles, the agitation being effected by revolving rollers. Inasmuch as the gold content was high, small samples were used and a high dilution was maintained. Solutions were thoroughly aërated prior to the test. With a high liquid-solid ratio, the amount of dissolved oxygen per sample would roughly cor-

respond to field conditions. Lime was added in quantities greater than that required to saturate the solution.

Experimental data obtained in these tests are presented in the tables.

The last of the series in Table II represents the results on the same product after it had been ground still finer. The average size particle in this last test was minus 1,600 mesh.

Inasmuch as ores from other telluride camps were hard to get, specimen material was concentrated. Variables were investigated as in the previous tables. The particles in this concentrate may be termed coarse in size, but all were minus 200 mesh and plus 400.

The product referred to in Table III was finely ground to pass 1,600 mesh.

Table III—Results of Cyanidation Tests

Product Tested—Calaverite from Cripple Creek, Colorado

Analysis
Gold, 38.90%
Silver, 1.21%
Others,[1] 59.89%

Time of Treatment, Hr.	Gold in Heads, %	Gold in Tails, %	Per Cent of Extraction	Condition of Test
48	38.90	17.78	54.2	Lime added
72	38.90	16.38	57.8	Lime added
96	38.90	15.80	59.3	Lime added
120	38.90	11.52	70.3	Lime added

[1]The word "others" appearing in the analysis of the various concentrates indicates the tellurium and base-metal content, inasmuch as no other minerals or gangue were present.

point. Inspection of the results in the latter table might indicate that reprecipitation of the gold had taken place. This condition was noted as occurring at

Table IV—Results of Cyanidation Tests

Product Tested—Same as in Test III, finely ground to pass 1,600 mesh

Time of Treatment, Hr.	Gold in Heads, %	Gold in Tails, %	Per Cent of Extraction	Condition of Test
24	38.90	5.37	86.1	Lime added
48	38.90	4.40	88.6	Lime added
96	38.90	1.37	96.4	Lime added
120	38.90	2.65	93.1	Lime added
48	38.90	3.70	90.4	Lime, commercial cyanide
72	38.90	0.74	98.0	Lime, commercial cyanide
96	38.90	0.67	98.2	Lime, commercial cyanide
24	38.90	18.83	51.5	No lime, 1/15000 Na_2O_2
24	38.90	2.27	94.1	No lime, 1/1875 Na_2O_2
24	38.90	0.16	99.5	No lime, 1/130 Na_2O_2
3	38.90	15.60	59.8	No lime, 1/1300 Na_2O_2
6	38.90	0.14	99.6	No lime, 1/130 Na_2O_2
24	38.90	24.76	36.3	No lime

Table V—Results of Cyanidation Tests

Product Tested—Sylvanite from Colorado

Analysis
Gold, 23.57%
Silver, 10.13%
Others,[1] 66.30%

Time of Treatment, Hr.	Gold in Heads, %	Gold in Tails, %	Per Cent of Extraction	Condition of Test
24	23.57	6.77	71.2	Lime added
48	23.57	3.56	84.4	Lime added
60	23.57	3.05	87.0	Lime added
96	23.57	2.69	88.5	Lime added
120	23.57	2.69	88.5	Lime added
136	23.57	3.19	86.3	Lime added
6	23.57	0.33	98.5	No lime, 1/165 Na_2O_2

This product was not finely ground.

[1] See footnote below Table III.

The tests were repeated, with the addition of sodium peroxide and commercial cyanide as variables.

The effect of adding sodium peroxide is clearly illustrated in Table IV. I understand that in field practice this chemical is added at the rate of 1 part to 18,000 parts of solution.

Attention is drawn to the head assay for gold in Tables III and IV, indicating that this concentrate was a high grade of calaverite, as the theoretical gold content for this mineral is around 40 per cent.

A series of tests were performed on a concentrate containing the mineral sylvanite, which came from Colorado. The results are given in Table V.

The specimen material from Kalgoorlie ores in West Australia was prepared for tests. The results are given in Table VI.

Many difficulties were encountered in this problem. At times, results were obtained which were obscure and unexplainable. Table VII will illustrate this

Table VII—Results of Cyanidation Tests

Time of Treatment, Hr.	Gold in Heads, %	Gold in Tails, %	Per Cent of Extraction	Condition of Test
48	15.76	1.49	87.8	Lime added
72	15.76	1.68	89.3	Lime added
96	15.76	2.29	85.5	Lime added
72	16.64	2.04	87.8	Lime added
96	16.64	2.13	87.2	Lime added
120	16.64	1.42	91.5	Lime added
168	16.64	2.22	86.7	Lime added

periods when the particle size was between 300 and 400 mesh. However, with finely ground particles, this phenomenon was not often observed. Possibly a difference in electrical potential was set up in the cyanide solution between the different elements in the tellurides. The dissolved gold may have been thrown out of solution, causing a decreased extraction.

Old and recent mill tailings from the different mines treating telluride ores were examined to ascertain the presence of gold-bearing tellurides. In some instances a few particles occurred, but the majority found were of base-metal nature. Also, free gold particles and others, which gave a jagged gold island in a clear lake, were found when examined by the fusion method.

The foregoing statement is in direct contrast to one made in an article which appeared in the *Engineering and Mining Journal* of October, 1932. The latter reads: "In spite of the fact that this concentrate contains a high percentage of gold tellurides, the extraction is around 98 per cent." The authors refer to a flotation concentrate recovered from cyanide tailings of a telluride ore.

Telluride fragments from a concentrate were mounted in bakelite and carefully polished. A microscopic examination revealed interesting structures. Fragments of free gold with telluride inclusions were found; likewise telluride particles with gold inclusions. Several complex structures were noted, in which a fragment of telluride was surrounded by free gold, and this in turn was incased by a second and different telluride.

To my knowledge, the isolation, the

Table VI—Results of Cyanidation Tests

Product tested—Specimen material from Kalgoorlie ores

Analysis
Gold, 14.75%
Silver, 1,38%
Others,[1] 83.87%

Time of Treatment, Hr.	Gold in Heads, %	Gold in Tails, %	Per Cent of Extraction	Condition of Test
24	14.75	4.39	70.2	Lime added
48	14.75	1.24	91.5	Lime added
60	14.75	1.10	92.5	Lime added
96	14.75	0.55	96.2	Lime added
60	14.75	8.47	42.5	No lime
48	14.75	0.92	93.7	Lime, commercial cyanide
96	14.75	0.98	99.4	Lime, commercial cyanide

[1] See footnote below Table III.

polishing of telluride fragments from an ore and the microscopic examination of them, were first accomplished in the research laboratories of the Department of Mining, University of Toronto.

Conclusions

1. Gold-bearing tellurides do yield up their gold to cyanide, if they are in a finely divided state and excess lime is used.

2. Sodium peroxide greatly reduces the time of treatment required for maximum extraction. It is not beneficial when used in quantities equivalent to commercial use.

3. The tellurides are very brittle, and, owing to their high gravity, will be retained in a mill circuit for a long time. They will thus be in a finely disseminated state, approximately minus 1,600 mesh or the size required to yield a maximum extraction of their gold.

4. Up to the present, gold-bearing tellurides have not been found in large quantities, in mill tailings, or in concentrates recoverable from them.

In a brief way, I have presented a summary of the results on the cyanidation of tellurides. Time has not permitted the investigation of interesting side trails, the byproduct of any research. More work should be done at centers treating these ores.

Chrysotile Asbestos

In the Bajenova District, U. S. S. R.

Walter A. RuKeyser

CHRYSOTILE ASBESTOS occurs economically in many scattered localities throughout the Soviet Union. The major deposits are in the Southern Urals at Orenburg and in the Bajenova-Alapaevsk-Krasnouralsk district, which hereafter will he referred to simply as Bajenova. The Ural occurrences are of the Thetford-Black Lake type of association. In the Caucasus is found a short brittle fiber which has not as yet been commercially expoited to any great extent. At Minusinsk, on the Yenesei River, in Eastern Siberia, near the Mongolian border, a long, iron-free chrysotile is found of the same association and general character as the Arizona. These deposits have been worked only in a desultory fashion, owing to adverse climate and poor transportation facilities.

The Bajenova deposits are by far the most important of the Soviet Union. They have in the past produced the major part of the entire Russian output, and today they are the source of the entire asbestos production of the Soviets. Before the revolution these properties were operated entirely by private capital, some of them belonging to the Imperial family. The mining methods were of the crudest, hand labor having been employed throughout. Semi-mechanical methods were used in milling. Only the longest grades of fiber (spinning and shingle stocks, in addition to crudes) were produced, owing to the lack of power, the 35-km. haul to the railroad, and the distance of the shipping point, Bajenova, from centers of consumption and points of export. Bajenova is 56 km. east of Sverdlovsk (formerly Ekaterinburg), on the Trans-Siberian Railroad. Sverdlovsk is an important industrial center and the chief city of the Ural district, having a population of about 120,000. It is something less than 1,800 km. east and north of Moscow, at latitude 56 deg., 45 sec. north.

The map reproduced in Fig. 1 on page 336 shows the four serpentine belts of the locality. The first, south and slightly west of Sverdlovsk, is non-productive. The second, which is the main producing zone of the Bajenova district where most of the major developments of the asbestos industry of the Soviet Union have been and are now taking place, is a mining community with a population of about 40,000 and is known as the town of Asbest. To the north of Asbest is the Alapaevsk-Reje zone, shorts being produced at those two respective points. To the west of this last belt is the Krasnouralsk area, which also only produces short fibers. These last three producing points have averaged about 2 per cent asbestos production from the rock as mined and milled by the former semi-mechanical methods, the entire production being paper stock and cement stock, with little shingle grade or better.

Production was resumed by the Soviets in the Bajenova district on a substantial scale in 1923, former plants and methods being utilized. According to the United States Department of Commerce ("Mineral Resources of the United States, 1929," Part II, by Oliver Bowles and B. H. Stoddard, page 110), about 85 per cent of the total Soviet production came from that district during the years 1924-27 (see Table I), one-third of which was obtained by hand picking.

I was first called into consultation by the Amtorg Trading Corporation, acting for and on behalf of the Soviet State Trust in charge of mining asbestos, Uralasbest, in 1928, when preliminary plans were desired for a 2,400 metric-ton mill (daily rock capacity) along strictly conventional Canadian lines. In August, 1929, I was called to Russia to act in a general consulting

Road from Asbest to emerald mines, 15 km. to the west

Table I—Production of Asbestos in the U. S. S. R.

Year ended Sept. 30	Metric Tons as Reported: Production	Metric Tons as Reported: Exports	Equivalent in Short Tons: Production	Equivalent in Short Tons: Exports
1924	7,932	5,634	8,744	6,210
1925	11,494	5,936	12,670	6,543
1926	17,953	7,215	19,790	7,953
1927	21,500	9,946	23,700	10,964

The *Economic Review* of the Soviet Union for Oct. 15, 1932, page 355 gives the following figures:

	Production, Metric Tons
1909–1913, annual average	16,840
1922–1923	4,780
1924–1925	12,330
1926–1927	21,156
1927–1928	(a) 30,300
1929	39,942
1930	54,083
1931	64,674
1932	(b)

(a) Not reported in periodical above mentioned; figures from personal notes of the writer.

(b) From information brought out at the Tariff Commission hearings in Washington, October, 1932, the production was given as something less than 60,000 tons, and that of 1931 as 61,000 tons.

———This is the first of three articles by Mr. RuKeyser on the Bajenova district. The first pertains to geology, the second to mining, and the third to milling.

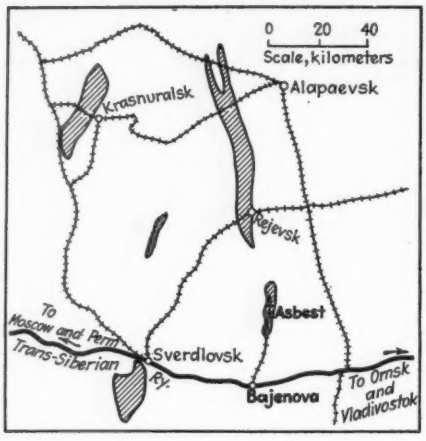

Fig. 1—Sketch map of the Bajenova asbestos district

capacity, and remained there until the end of that year. I returned in June, 1930, at the request of the Supreme Council of National Economy, to both consult and actively supervise this third and final contact, which was terminated by Uralasbest in the spring of 1931.

What is not generally understood outside of Russia is that the Five-Year Plan was being continually changed for each industry throughout the attempt at its fulfillment. This was particularly true in the asbestos-mining industry. According to an early variant, production was to have been 100,000 metric tons by 1932, but later in the same year the figure was increased to 180,000 tons. I helped in the setting of 99,000 tons as the proposed production for 1931.

The demand for asbestos internally in the Soviet Union, according to figures given out by the Mineralrud (All Union Association of the Mining Industry for the Recovery and Sale of Non-metallic Minerals), is given as 52,000 tons in 1931, 100,670 tons for 1932, and 171,745 tons for 1933. Therefore, to take care of the export program for 1933, the total production for this year was accordingly fixed at 250,000 tons. I was consulted during the setting of these figures and can testify as to their accuracy. Typical Russian psychology is seen in estimating production figures down to the last five tons. Although the plan was fulfilled 90 to 95 per cent of the norm during my sojourn, production for the year 1932 did not come within 60 per cent of the norm. Plans projected in early 1931 provided that a so-called mill No. 3 should yield 60,000 tons annually, and proposed mills Nos. 4 and 5, 60,000 to 80,000 tons each. Efficiency of labor was to be increased and the costs of production were to be reduced, as will be emphasized in the two succeeding articles on mining and milling.

A report, "Contributions to the Knowledge of the Chrysotile Asbestos Deposits at the Bajenova Mining District in the Urals," by P. M. Tatarinov, was issued by the Geological Committee, Leningrad, in 1928. This comprises a complete and detailed description of the geology, mineralogy, petrography, associations, and genesis of the deposits of the Bajenova district. A summary in English appended to the report includes a geological map, which is reproduced in Fig. 2. At the time the report was written the material available—at least that in English—was extremely sketchy and inaccurate, as proved by the preliminary geological survey that I made on my first trip to Russia in 1929. Observations and notes made at that time substantiated Mr. Tatarinov's report in detail.

The chrysotile asbestos deposits at Asbest are 85 km. northeast of Sverdlovsk, on the eastern slope of the Urals. In this region the topography is comparatively flat, the area being thickly wooded and swampy, and affording not nearly the relief found in the Thetford district of Quebec. The area lies in the basin of two rivers known as the Bolshoi Reft and Griasnushka, which are tributaries of the Pyshma flowing northward into the Arctic Ocean.

Geologic Observations

The serpentinized area of the intrusion of basic rocks strikes north and south at Asbest for 21 km. In the main productive portion of the serpentine zone the major intrusion consists of peridotites, reported by Tatarinov to be of the harzburgite type, consisting of from 80 to 90 per cent olivine, enstatite, and a small admixture of monoclinal pyroxene, in addition to magnetite and minerals of the picrite group. In the northern end of the zone pyroxenites substitute for the peridotites. On the west a gabbro massive contacts the intrusion of the ultrabasic rock. A complete analogy is thus found in the gabbro-peridotite intrusion, which undoubtedly formed derivatives from a single magma in the various stages of differentiation, as observed in the Thetford district of Canada. The various phases of this differentiation are exemplified by dunite, pyroxenite, microgabbro, plagiaplite, and hornblend-pegmatite veins of comparatively small thickness, the last with a prevailing northwest strike. The dunite and pyroxenite have been subjected to serpentinization and comprise the locus of the asbestos veins. In addition, veins and lenses of calc-silicate rocks prevail, which also strike northwest and are typified by garnet-pyroxene, garnet-vesuvianite, and garnet-chlorite.

My observations in the field lead me to believe that the serpentized masses have resulted as a direct alteration of the pyroxenites, peridotites, and microgabbro. Mr. Tatarinov has confirmed field observations by microscopic work, which shows conclusively the derivation of the serpentine from the gabbro-peridotite formation. This again is analogous to the origin of the Thetford deposits. Running through the gabbro, pyroxenite, and peridotite occur large dikes of diabase and diabase-porphyry, striking north and south. To the east a major granite mass contacts which is younger in age and probably related to the dikes of aplite that intrude the basic rocks. As in the instance of the Thetford deposits, the basic rocks including the serpentine have undergone contact metamorphism where they come in contact with the granite, the end products being for the most part talc and chlorite schists. The intruding dikes obtain a maximum thickness of about 50 m. and have an unbroken length that often extends for several kilometers.

The acid phase of the intrusion has resulted in a differentiation of aplite, quartz-porphyry, and diorite-aplite, in addition to the granite, and produced the same end products of metamorphism. The peridotites and pyroxenites have been serpentinized along ellipsoidal zones that surround the original unaffected parent rock. These ellipsoidal margins vary in thickness, the average width exceeding 50 m. Apparently, these serpentine bands are the result of fracture zones caused by the shrinkage in the mass of the original intrusion. Therefore, these fracture zones comprise a crust which is the locus of the productive serpentine-asbestos deposits.

Two distinct vein systems are to be noted as a result of the asbestosization of the serpentine. One (see Fig. 3) is represented by veins lenticular in shape, that extend in all directions, intersecting one another at various angles. The second (see Fig. 4) is a series of parallel veins offering a typical ribbon structure, such as is found at Vimy Ridge, Quebec. Tatarinov suggests that the veins of asbestos have probably arisen in conjunction with the alteration of the peridotites into serpentine, owing to the increase in rock volume during

Fig. 3—Lenticular veins. Coin on the left is an English shilling; that on the right is a half crown

the processes of metamorphism, and he substantiates my theory that these cracks which are the loci of the asbestos veins are largely in the nature of exfoliation fractures arising from the tendency of peridotie to split into concentric layers.

The general analogy between the Bajenova deposits and those of the Thetford district in Quebec is readily discernible. However, three or four marked and important differences exist. First, at Bajenova ellipsoidal masses of peridotite surrounded by serpentine occur, in every instance indicating that the metamorphic action did not penetrate farther than the shell forming the locus of asbestos deposition. Second, narrow fingers of serpentine, not more than a few inches in width, extend into the unaltered peridotite at Bajenova—a feature which I did not commonly observe in the Thetford district. These fingers of serpentine invariably carry veins of asbestos of high quality and long unbroken fiber length. Third, invariably in Canada the longest and best quality fiber occurs at or near the contact with dikes of aplite or granite. In the Bajenova deposits the best asbestos occurs at considerable distances from the acidic masses. The dikes of acid rock here seem to have an ill-defined relationship to the serpentinization of the peridotites, often passing through barren peridotite masses. Further, the strike of the acidic rocks, with their vertical dip, is at right angles to the usual plane of asbestosization.

Character of Veins

Another minor peculiarity of the asbestos veins of this district is that, in the main, they are "looser" and break away from the wall rocks more easily than the Thetford deposits. This is clearly shown in Fig. 3. The width of the vein of asbestos is indicated by the coins, the coin at the left being an English shilling, and that at the right a half crown.

The elliptical trace of the asbestos-bearing serpentine masses surrounding barren peridotite is clearly shown in the geological map reproduced in Fig. 2. One of the mines where the productive operations have encircled a barren peridotite mass is shown in Fig. 6, indentations into this "island" of peridotite being where fingers of asbestos have penetrated therein. "Bowlders" of peridotite, around which serpentinization with concomitant asbestos veins has penetrated, are a common occurrence. The width of the "shell" of the serpentine area surrounding the "island" of peridotite is apparent at the right of Fig. 6. Unlike the Canadian deposits, the asbestos-bearing serpentine zones in the Bajenova district are mineable for their entire width, with the complete absence of inner zones or bands of "dead" or "dry" rock. These deposits have the economic advantage of almost complete elimination of

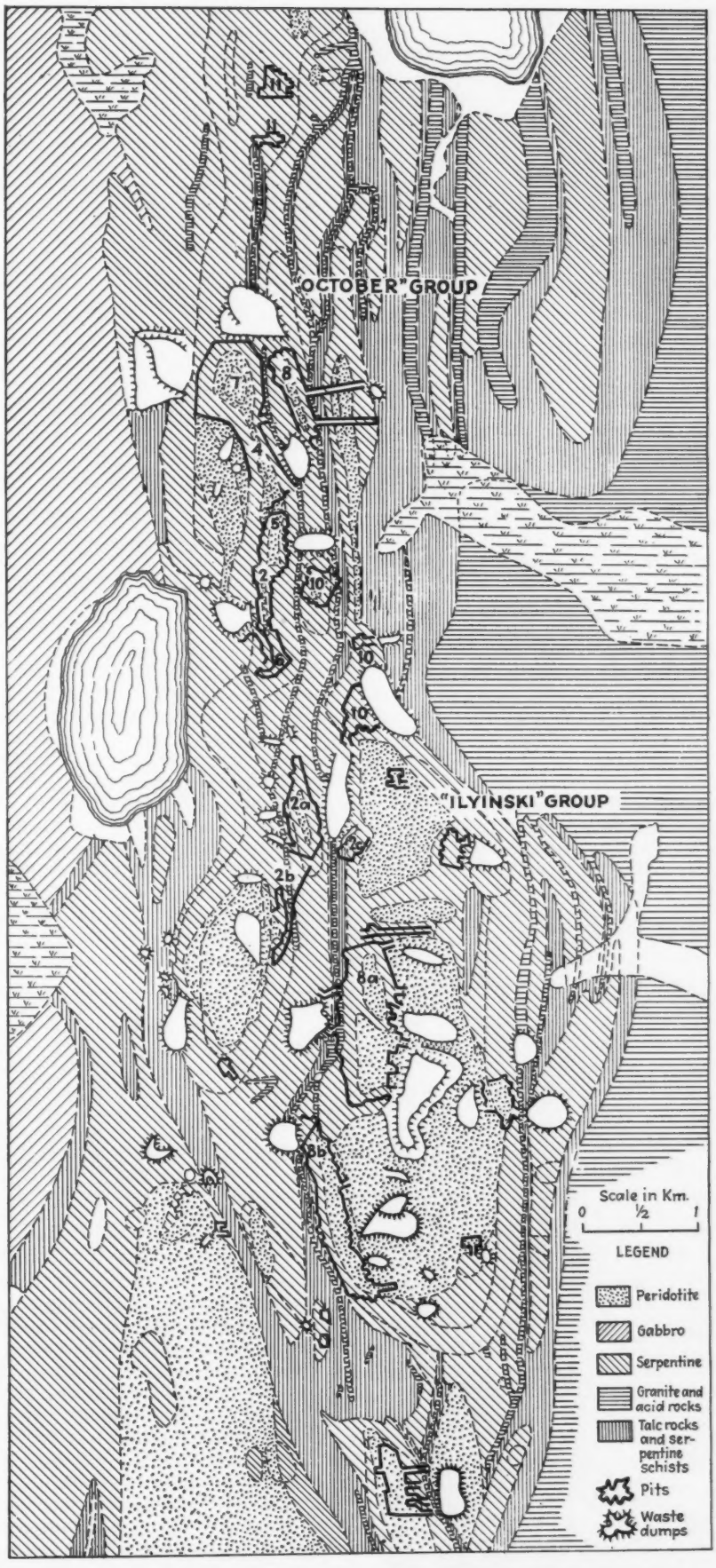

Fig. 2—Geological map of the Bajenova district. After P. M. Tatarinov

separation of productive rock from dry rock during the mining operations on any productive zone. However, the entire periphery of the ellipsoidal masses of peridotite cannot be mined commercially. The map reproduced in Fig. 5 shows the most southern productive area of the Bajenova district, where the mines known as the Ilyinski group are situated. The outline of the pits indicates the approximate margins of the commercially potential zones in the serpentine areas indicated by horizontal cross-hatching. The aplite-diorite dikes are indicated by the vertical lines.

Tatarinov, on page 48 of the aforesaid report, comments on what may be considered as a fourth outstanding difference between the Canadian and the Ural deposits. He says: "The highest interest, however, attaches to fissures with chrysotile asbestos veins contained in unserpentinized peridotites adjoining the massive serpentine zone. Some of these fissures are represented by the widest asbestos veins extending some scores of meters along the strike; they have a marked northwest strike and seem to be a result of regional compression."

Analogous to the Thetford deposits is a constant ratio between the width of an entire band of serpentine to that of the asbestos inclosed therein and noted to be identical with the ratio observed by Dresser and others in the Canadian area. This average ratio is in both instances 6.5:1. Serpentine in the Ural deposits, one should remember, is derived in the main from olivine and to a lesser extent from pyroxene. Slip-fiber occurs comparatively rarely in the Bajenova deposits, mostly in shear planes, and obviously as the result of postmineral action. Nothing corresponding to the Robertson-East Broughton mode of occurrence has as yet been discovered in connection with the Bajenova deposits.

The serpentine and chrysotile asbestos of the Bajenova district are found with almost the identical mineralogical associations as described by Graham and Dresser in their work on the Canadian deposits. Some of the more common minerals that I observed at Asbest are chromite, magnetite, chlorite, actinolite, calcite and other carbonate minerals, including dolomite and aragonite, magnesite and hydromagnesite; other metamorphic minerals, such as garnet, vesuvianite, talc, chalcedony, and opal, in addition to the minerals making up the parent rocks, also characterize the general mineralization.

Fig. 4—Parallel veins showing typical ribbon structure

Grade of the Asbestos.

A popular belief exists outside of Russia that Bajenova asbestos is extraordinarily high in iron content. Table II shows a comparison between Canadian, taken from page 60 of Dresser's "Memoir No. 22," and the Bajenova, taken from my notes based on information obtained from Leningrad. This table indicates: (1) The Bajenova product has approximately the same total iron content as the Canadian, but, whereas the Canadian is high in ferric iron, the Bajenova is high in ferrous. This probably accounts for the greater discoloration of the Ural asbestos upon weathering. (2) The Bajenova fiber is comparatively high in CaO compared to the Thetford fiber, which, in turn, probably accounts for its somewhat lesser degree of silkiness. (3) Canadian chrysotile runs higher in combined water content, which probably is the reason for the somewhat harsher fiber found in the Bajenova deposits. However, as explained in the following paragraph, my opinion is that this is also a surface phenomenon resulting from partial dehydration upon weathering.

Table II—Chemical Analyses of Canadian and Bajenova Asbestos

	Canadian	Bajenova
SiO_2	39.62	39.28
TiO_2	None	None
Al_2O_3	0.81	1.75
Fe_2O_3	4.52	0.40
FeO	1.90	5.37
MgO	39.73	40.05
CaO	Trace	1.74
H_2O (combined)	13.75	11.52
	100.33	100.11

Another important advantage enjoyed by the Bajenova deposits in comparison with the Canadian is their comparative thinness of overburden. The depth of overburden, for instance, at pit No. 7 of the "October" group of mines, which is in the central part of the district, is 8 ft., the material being stripped by hand methods on my first arrival in the district in 1929. At another point in the northwest corner of the same pit depth of overburden was a maximum for anywhere in the district. Here the bank, about 12 ft. in depth, is being stripped mechanically by electric shovel.

Whereas the overburden in Canada, which runs to depths as high as 120 ft., is composed mainly of glacial drift, including a high proportion of large bowlders and much compact, consolidated material, that of the Bajenova district is composed of light, unconsolidated sands and gravels, resulting from river and lacustrine deposition. At many of the pits the serpentine outcrops to the surface, being covered only with a few inches of soil and vegetation. In the northern group of the October Mines (pit No. 11), the overburden consisted mainly of peat, which in the stripping was cut as fuel.

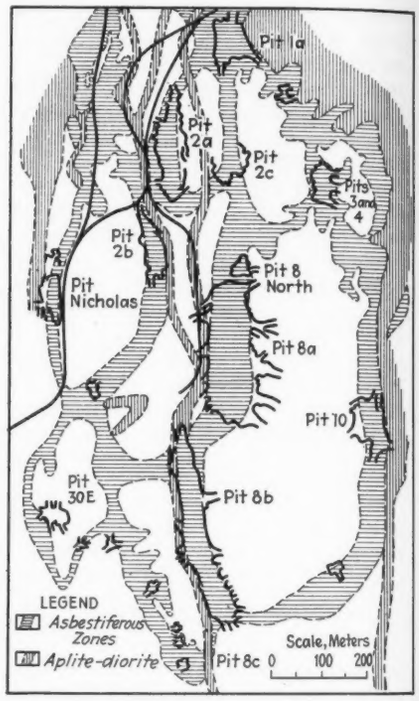

Fig. 5—Ilyinski group of mines in the southern part of the Bajenova district

In Canada the asbestos deposits have been glaciated in comparatively recent geological times, and have further been protected against extensive weathering by the heavy overburden. Contrasted to this, the Bajenova deposits have been exposed to extensive weathering action. The deepest open-cut working in 1931 was only approximately 30 m., the average depth of the pits being less than 20 m. I observed a distinct change in the nature of the fiber as one proceeded downward from the surface along the working face. The harsher, brownish, more-brittle fiber gives way at depth to greenish, silky material of high tensile strength. Inasmuch as the bulk of Russian production to date has come from these comparatively shallow workings, the idea has arisen throughout the industry that the former is typical of the Russian material. My belief is that as increased depth is being and will be attained, the Russian asbestos from the Bajenova district will hardly,

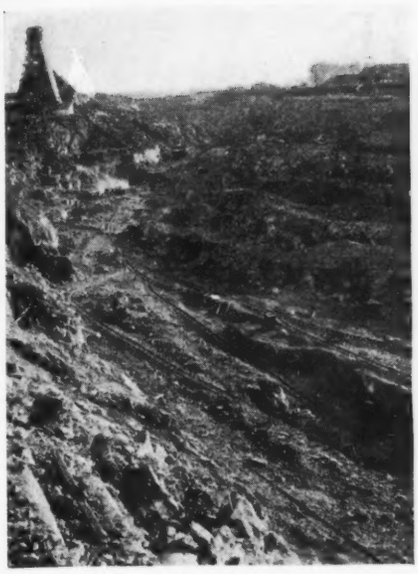

Fig. 6—One of the mines. Operations encircle a barren peridotite mass shown at the right

if at all, be distinguishable in physical characteristics from the average derived from the Thetford-Black Lake area. This was substantiated by observations made in the underground workings below 50 m. in depth.

Ore Reserves

Extensive and extremely systematic drilling and test-pitting has been done by the Geological Department of Uralasbest throughout the length and breadth of the entire Bajenova deposits. To a depth of only 50 m. this exploration and development work at Asbest has indicated 2,600,000 tons of asbestos fiber; at Krasnouralsk, 300,000 tons; and at the Spartak 130,000; a total of more than 3,000,000 tons of asbestos fiber. About 60,000,000 cu.m. of ore has been indicated. The asbestos fiber reserve has thus been calculated at the extremely conservative figure of 2 per cent extraction (or 50 kg. to 1 cu.m. of rock, the aforesaid figures being metric tons). Actual extraction in my experience varied from 2½ to 4 per cent, detailed figures for which will be given in the third article on milling. With the new mechanical methods and modern milling plants, a 4½ per cent recovery from the mines at the Asbest for all grades, including shorts, is to my mind conservative. Using this figure, the reserves would be doubled. Preliminary deeper drilling to a vertical depth of 150 m. has indicated a conservative fiber reserve of between 8,000,000 and 9,000,000 tons.

Figures taken for the fiscal year October, 1927-October, 1928, presented in Table III show the percentage extraction by the old methods from the entire district, together with the proportions of each grade produced.

Table III—Canadian and U. S. S. R. Production Statistics

Canada Production, 1928

Grade	Output, Short Tons	Per Cent of Total Output
Crude No. 1	706	0.536
Crude No. 2	2,784	2.12
Other crudes	507	0.387
All crudes	3,997	3.043
Spinning stock	14,051	10.75
Shingle stock	41,975	31.95
Millboard and paper stock	71,141	54.25
Crude No. 1 through paper stock	131,164	99.993
Fillers, floats, miscellaneous	142,701	.....
Total	273,865	.....

U. S. S. R. Production, October, 1927—October, 1928

Grade	Output, Metric Tons	Per Cent of Total Output
All crudes	300	1.0
No. 1 long spinning fiber	600	2.0
No. 2 short spinning fiber	2,400	8.0
No. 3 magnesia stock	4,800	16.0
No. 4 shingle stock	9,900	32.5
No. 5 good paper stock	7,800	25.6
No. 6 poor paper stock (cement.)	4,500	14.9
Total	30,300	100.00

If one compares the same grades made in Canada in 1928 with those from the Bajenova district, the following facts become immediately apparent:

1. Prices received for spinning fibers from Russia indicate strongly that these are in reality partially opened crudes.

2. The combined percentage of crudes and spinning stock for Canada is approximately 13.79 per cent of the production of all grades through shorts. This compares with 27 per cent for Bajenova, and clearly indicates that though the percentage of recovery from the rock may be lower than the Canadian, the value of the output is higher.

3. Recovery of shingle stock in the Canadian ore, as treated by the mills, is about 32 per cent, being almost identical with the 32½ per cent recovered in 1928 at Bajenova.

4. Increased spinning fiber production of Bajenova over Canada is thrown into the increased proportion of paper stock and other shorts, the figure for Canada being 54.25 per cent as opposed to 40.5 per cent for the Ural production.

5. If the total production from Canada, including fillers, floats, and other material not made during that year in Russia, should be included in the total production, the respective percentages for the Thetford district would be further cut about in half.

6. Average value per ton of the Russian production was $135 for 30,300 metric tons, or $121 approximately for over 33,000 short tons. This is about twice the value per ton of the Canadian production. My belief is that the increased value per ton of the Russian output and per ton of rock mined has resulted not only from a longer average fiber contained therein but also, principally, from the method of treatment in vogue in Russia at that time. A corollary thereto would appear to be that the methods of extraction which were typical of the Russian technique at that time may be in some respects superior to the standard Canadian practice. This will be discussed in the third article of the series.

7. A total of 30,300 metric tons of fiber, through paper stock, was produced from 1,126,381 metric tons of rock mined, giving a percentage yield of 2.59. Inasmuch as material shorter than paper stock was not recovered, and taking the same percentage of shorts as in the total production of Canada, an indicated content of better than 5 per cent in the Russian rock would result. On this basis the percentage of asbestos in the Russian ore reserves, when all grades shall be produced, will compare very favorably with the average of the Thetford district of about 6 per cent. That this additional recovery can be made from the Russian ores was proved by me in my reworking of the old mill dumps, using standard Canadian milling practice.

8. The 1,126,381 metric tons, as mined had a total yield of about $4,079,000 (1928 selling prices). This gives a value per ton of rock in the ground of $3.63, compared to a little over $2 for Canada.

MINE HAULAGE

The Combination-type Electric Locomotive

H. A. Neustaedter

LOCAL CONDITIONS may largely determine the selection of a particular piece of equipment, especially when the machine has been built to meet special conditions. However, one must bear in mind that changes take place from time to time, not only in the conditions but in the equipment itself, through improvement and modification of design. Thus the question arises as to how often a mining company ought to improve its existing installation. Factors entering into this consideration are: the need for cutting costs; the prospective life of property; the company policy; financial ability to make the change; and whether or not the savings will suffice to amortize the investment. As for the last, the period of amortization must be determined for each plant. At one property with which I was connected, certain types of equipment had to be amortized within three to five years. This period can well be applied to underground locomotives. The cycle of changes in such equipment at one mine was about six years.

The so-called sheet-ground deposits of Southeast Missouri are worked under many conditions not met elsewhere. One such circumstance was the result of centralization of operations which required the hauling of all ore underground from various mines to a central hoisting shaft at the mill. The main haulage levels of the different mines were at different elevations, and a large part of the ore was hauled with the grade against the load. This condition of making long hauls of the load against the grade would call for a trolley unit. Further, in developing large orebodies, minor deposits are often found a short distance away. Inasmuch as the tonnage to be derived from some of these is small, the expenditure for opening them for production must also be small. In this instance, the less spent on bonding rails and installing trolley wire, the smaller will be the development cost and the actual mining cost per ton in that stope. A trolley locomotive which could operate at a greater distance from the main line than is possible with a reel would therefore afford a great advantage. A combination locomotive will meet both of these requirements.

To meet conditions such as those cited, the Desloge Consolidated Lead Company purchased a 15-ton Mancha combination unit, having a battery of 75 kw.-hr. capacity. Charging was done at all times by manual or automatic control when the load was light, but generally between shifts. Speed when running on the trolley was 6 to 10 m.p.h. and when operating on the battery 3½ to 7 m.p.h. Operating voltage was 250 to 280 volts on the trolley and 200 to 220 on the battery.

The track on main haulage lines was of 30-in. gage 56-lb. rails, bonded for trolley operation. Branch tracks and loops were of 30-lb. rail and bonded only when it was necessary to extend trolley operations to balance load on the battery.

Two-ton solid-end cars with Flemming-Hyatt bearings, which made it possible to pull heavy loads against the grade, were used. Trains usually consisted of 40 cars. Maximum haul was 6,000 ft., 1,000 ft. of which had a 2¾ per cent grade against the load and an average adverse grade of 1.03 per cent. Against every load also there was 1,500 ft. of 1.4 per cent grade. Average haul per shift was 855 ton-miles, the maximum being 930 ton-miles. This corresponded to 1,250 and 1,350 tons of ore hauled per shift.

The costs I am able to submit include the total main-line operating expense, which is divided between labor and supplies. Labor cost was 2.02c. per ton, covering the motorman at $5.05 and the helper at $5, as well as any labor on main-line tracks and the repair men on locomotive and cars. The cost of supplies was 11.61c., including all rails and other material for maintenance of a main haulage line and its rolling stock.

The combination locomotive, though not affording the complete safety of a storage-battery unit, has many advantages over the latter, as well as some with respect to safety over the trolley units. Advantages over the battery-type locomotive are: Its capacity to stand up under long hard pulls; its ability to charge without interfering with operations; its need of only one transfer rack to permit the battery to be taken off for inspection or repairs, as compared with two racks and an extra battery; its ability to give service uninterrupted by changing batteries, as well as to go from a central charging station to the place of operation without discharging the battery.

Advantages of the combination type over the trolley type are: Safety in that the men of the crew always have light, even though the power fails or the trolley pole jumps off the wire; the possibility of omitting trolley wires at chutes or loops where they would be a hazard to men; and the availability on all occasions of some kind of power. A disadvantage is that first cost is higher. This is to be expected because of the flexibility of the unit. Another disadvantage attributed to the trolley- or combination-type locomotive is the need for installing a large motor-generator set, which will usually increase the demand charge for power. This, however, is not always the case. Some mines are able to balance their load on pumping operations. In large mines employing mechanical loading and other motor power equipment, the use of a motor-generator set with a leading power factor to act as a synchronous condenser might offset this disadvantage.

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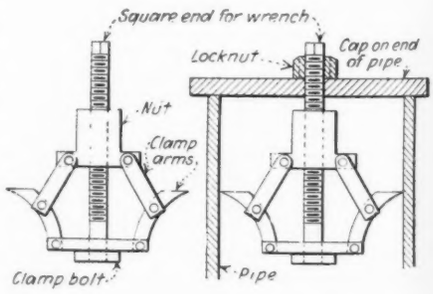
Adjustable Gear or Wheel Puller

An adjustable gear or wheel puller made as illustrated can be used for many jobs in a mine machine shop. The cost of making it is small, and it will pay for itself many times over, especially when a breakdown occurs, or when repairs must be made in a hurry. One puller can be made to accommodate many gears of different sizes. This depends on length of top plate, which has a slotted or elongated hole to allow for gears of different widths, the bolts being opened out as desired.



This puller operates as does the standard gear puller. The lower clamps should be kept as close to the work as possible. If the gear or pinion is exceptionally tight on the shaft, use a chain around the body of the job, over both bolts, to keep the clamps from slipping off the gear face.

Trends and Developments In the Industry

Silver Agreement Reached at London

Representatives of Eight Countries Sign Four-Year Proposal Restricting Sales Of the Metal and Providing for Its Increased Utilization By Governments for Monetary Purposes

REPRESENTATIVES of eight countries attending the World Economic Conference in London signed a four-year agreement on July 22 to restrict the governmental sale of silver and to increase its use for monetary purposes. The agreement has been generally hailed as an outstanding achievement on the part of Senator Key Pittman, of Nevada, and as the first important accomplishment of the conference. As a delegate to the conference and a champion of the silver producers' cause, Senator Pittman presented early in the conference deliberations a resolution on silver that was adopted by the conference monetary committee and which subsequently emerged from prolonged consideration in subcommittee sessions to provide a basis for discussions that led to the drafting of the aforesaid agreement.

Countries whose conference delegates signed the agreement were: Australia, Canada, United States, Mexico, Peru, India, Spain, and China. The agreement, subject to the ratification of the respective governments, provides that the three principal silver-holding countries—India, Spain, and China—will sell limited amounts of their silver stocks over a four-year period, beginning Jan. 1, 1934; whereas the five leading silver-producing countries—Australia, Canada, United States, Mexico, and Peru—will buy or withdraw from mine production a total of 35,000,000 oz. of silver yearly. This silver would be impounded in their respective treasuries to be used for currency purposes, either as coinage or currency reserves. The sales limitation allotments are: India, an average of 35,000,000 oz. yearly, but not more than 50,000,000 oz. in any year, or 140,000,000 oz. for the four years; Spain, 5,000,000 oz. yearly or 20,000,000 oz. for the total period; China agrees not to sell any silver from demonetized coinage during the period. In brief, therefore, the five producing countries agree to absorb during the four years all but 20,000,000 oz., which would comprise the total amount that would then reach the open market from governmental sources. All the countries agree not to debase silver coinage below 800/1,000's fine, and also to substitute, as far as possible, silver coins for paper currency of low denomination.

An additional provision of the agreement specifies that transfers of silver from India to the United States for war debt payments shall not be included in the limitation allotment, inasmuch as the United States Treasury's acceptance of the metal would be considered as an additional removal of silver from the market and as furthering the metal's monetary use.

A supplementary agreement allocates to each of the five producing countries the share of the 35,000,000 oz. of silver that it must absorb annually. United States is understood to have been allotted a major share of 24,000,000 oz. yearly. This allotment, on the basis of 50c. per ounce, would involve the purchase of $12,000,000 worth of silver from the mines of this country each year.

Under the terms of the agreement, ratifications by the several countries concerned must be deposited at Washington by April 1, 1934. The agreement provides for its own termination whenever India's allotted sales, plus the transfers of silver for war debt payments, shall reach 175,000,000 oz.

Senator Pittman is quoted as saying that the agreement gives ample substance to his objective of raisng and stabilizing the price of silver, "in order to increase the purchasing power of half the world." He holds it to be the real driving power behind the resolution, adopted by the conference monetary committee, declaring for control of silver sales and recording all the nations as against further debasement of silver coins and in favor of substitution of silver coins for low-value notes. His program did not mean bimetallism but that the way had been paved to the proper monetary use of silver on a stabilized level, while gold continued to be the international measure of values.

British South Africa Company May Aid Copper Industry

Acquisition by the government of Southern Rhodesia of all the mining rights in that territory from the British South Africa Company, for a cash payment of £2,000,000, prompts the suggestion that the money will be used by the chartered company to develop intensively the copper-mining industry of Northern Rhodesia, present and prospective, in which country it retains all mineral rights, and in which it possesses considerable financial interest. It therefore is likely to encourage activity that will lead to an increase of its revenues from royalties and augment the operation of the Rhodesian railroads. Of interest also is the fact that the recent issue of 6 per cent debenture stock of Roan Antelope Copper Mines, at 105 per cent, was fully subscribed to by cash payments and by exchanges of 7 per cent debenture stock.

Mufulira to Begin Producing

Mufulira Copper Mines will begin producing copper regularly, but on a restricted scale, about the beginning of the coming year. The work of unwatering the mine will begin immediately. No other preparations will be necessary, except that of getting in supplies, as the property is fully equipped and the mill was run a short time before operations were suspended.

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Rhokana to Erect Refinery

Rhokana Corporation announces that it will erect forthwith an electrolytic copper refinery at the N'Kana property, in Northern Rhodesia. This site was decided on after much consideration. The plant will have a capacity of 36,500 short tons annually, and is so designed that it can be expanded whenever copper conditions warrant.

World Output of Gold Unchanged

Production of the Metal in the United States Continues to Decline —Many New Enterprises Under Way in Various Mining Districts Here and Abroad

WORLD PRODUCTION of gold, as shown in the accompanying table, continues on about the same level as in recent months. In fact, the daily rate of output for June is almost identical with that for both April and May. Interest in the metal, however, continues to expand, and, as indicated in the appended references to specific operations, numerous new ventures are under way, both in this country and abroad. Uncertainty relative to the immediate future position and price of the metal, discussed in the article "What Price Gold?" on pages 325-27 of this issue, constitutes, nevertheless, a disturbing factor for the gold producer. In the last month, however, developments in this connection have generally been encouraging, and a steady trend toward a more stabilized position for gold seems probable.

Although the total output of 919,000 oz. of gold during June by the leading gold-producing country—South Africa—was somewhat less than in the preceding month, when its output was 944,000 oz., the daily rate of production for the shorter month was at about the level that prevailed in May, as indicated by the statistics shown in the table. Canadian production, on the other hand, increased by about 2,000 oz. in June, the total for the month being 240,000 oz., as compared with 238,000 oz. in May. Output of the United States, as reflected by mint receipts, continued to exhibit the sharp decline of recent months, falling off to 142,000 oz., a decrease of about 23 per cent from the total of 185,000 oz. for May. This steady and marked reduction in gold production of the United States is generally held to be the result of governmental restrictions that have denied to the gold miner the world market price for this product. New rulings of the Attorney General that permit the export of gold ore and concentrate, discussed in detail on page 347, are expected to encourage an increase in gold-mining activity.

The price that the gold miner receives for his metal varies in the different countries, depending principally on whether the currency of his country is on a gold-standard basis. South African and Canadian producers, for instance, are now receiving a premium that amounts to about 50 per cent. A similar premium would accrue to United States producers if the sale of their gold abroad were permitted. The devaluation of the United States dollar that would make possible this premium, and the devaluation of the pound sterling (the South African pound is linked to the pound sterling) responsible for the premium on South African gold, and which two devaluated currencies produce the premium on Canadian gold, are shown in the accompanying graph reproduced from *The Business Week*. Devaluation of the pound and dollar, as indicated in the chart, recently reached a level where their respective values in terms of each other represented par values, or in other words, the extent of devaluation of each currency, with respect to the gold-standard franc, was simultaneously of equal degree.

World Production of Gold
(American Bureau of Metal Statistics)

In Fine Ounces

1933:	April	May	June
United States (*a*)	189,000	185,000	142,000
Canada	237,000	238,000	240,000
Mexico	44,000	50,000	(*f*) 50,000
South America	68,000	63,000	64,000
British India (*e*)	28,000	27,000	26,000
Japan (*e*)	34,000	36,000	36,000
Australia (*b*)	92,000	94,000	98,000
South Africa	895,000	944,000	919,000
Belgian Congo	21,000	21,000	22,000
Rhodesia	54,000	53,000	54,000
British West Africa	27,000	29,000	28,000
Russia (*c*)	(*f*) 160,000	(*f*) 160,000	(*f*) 160,000
Elsewhere (*d*)	(*f*) 70,000	(*f*) 75,000	(*f*) 75,000
Totals	1,919,000	1,975,000	1,914,000

(*a*) Includes Philippines. (*b*) Includes New Zealand and New Guinea. (*c*) Chiefly Siberia; 1933 estimated at average rate of 1932. (*d*) Includes West Indies, Central America, Europe, and Asiatic and African lands not separately reported; estimated. (*e*) Principal mines; nearly complete. (*f*) Conjectural.

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California

The Spanish Mining Company, operating the old Spanish mine, in Nevada County, will soon resume milling operations at the rate of 50 tons per day. Satisfactory progress is being made in the construction of a cyanide plant and an 8,000-ft. aërial tramway. The company is also doing development work at the North San Juan mine, near North San Juan.

Ballard Plymouth Gold Mines has resumed work at the Lopez mine, near Plymouth. The 200-ft. shaft has been dewatered, and a crew is employed in development work. Erection of a small mill is planned.

Reports are current that Lucky Tiger-Combination has acquired control of the Empress gold mine, in the Newtown district, near Grass Valley. The company also operates mines in Mexico.

Unwatering of the Bullion mine, which is being reopened south of Grass Valley, has been completed. Auxiliary pumping equipment and the remains of the old Cornish pump, used before the 1,500-ft. shaft was closed 26 years ago, are being removed, preparatory to the comprehensive plan of development to be undertaken on various levels. The property is controlled by Grass Valley-Bullion Mines.

With a substantial tonnage of commercial ore blocked out in the upper levels, Seneca Gold Mining is reconditioning the mill at the White Lily mine, near Seneca, Plumas County. A tramway has been built recently from the mine to the reduction plant, and surface buildings and equipment have been improved.

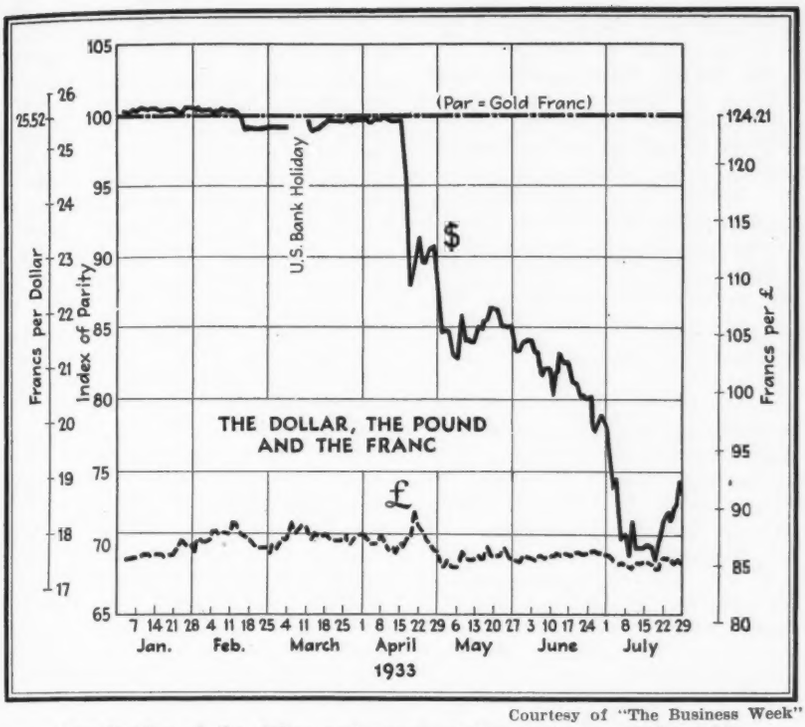
Alaska

A new strike of free-milling gold ore, in a 2-ft. vein on the 200-ft. level, has just been reported at the Ramer mine, on the Bremner River, Alaska, about 35 miles from McCarthy, the inland terminus of the Copper River & Northwestern Railroad. McCarthy is about 191 miles from Cordova. S. L. and Peter Ramer have been developing their property since 1927.

Enough drifting has been done on the new vein to open up a large body of the ore, which seems to insure operation on an extensive scale. Ramer Brothers plan to increase the present crew of twelve men and rush development of the new find in an attempt to get into production this year. Local opinion appraises the find as the richest free-gold discovery in Alaska in recent years.

Nevada

The new 50-ton mill of the Monarch Gold Ledge Mines in eastern Churchill County was started recently in the presence of Governor Fred Balzar and 200 guests from nothern Nevada towns. Ore is trucked 4½ miles from the mine, down Coffee Pot Canyon, and dumped on to a grizzly. It falls into the crusher bin, the fines passing through a chute to the elevator boot. By a Link-Belt bucket elevator, the crushed ore is raised to the mill bin and fed from the jaw crusher by a plunger-type feeder to a 54x20-in. Hardinge conical ball mill, operating in closed circuit with a Dorr Simplex classifier. Thence the ore passes to two amalgamating plates, to two Pierce amalgamators, and to a Deister-Plato concentrating table. Tailing is pumped 400 ft. to a waste pond. A clean-up barrel and retorts are available for making bullion. Power for the mill lighting and pumping systems is supplied by a 125-hp. Fairbanks-Morse two-cylinder, Y-type semi-diesel engine, direct-connected to a 2,300-volt generator, belted to an exciter. The mine is opened by a 600-ft. haulage tunnel and three shafts. Ore is raised through the "B" central vertical shaft to a large pocket and drawn to mine cars at the haulage level, whence it is trammed to the loading bin. A substantial tonnage of good ore has been developed by drifts and raises to



Courtesy of "The Business Week"

Devaluation of the dollar and pound sterling in terms of the gold-standard franc. When the United States went off the gold standard last April the dollar dropped to about 80 per cent of its former value. It has since declined to less than 70 per cent of that value.

the 200-ft. level. The company has built a model camp near the mill and a few hundred feet from the Lincoln Highway.

In the Comstock district, an announcement has been made by J. M. Leonard, head of Comstock Tunnel & Drainage, owning the Sutro tunnel and many of the old bonanza lode mines, that his company has made arrangements further to develop and prepare for stoping the large orebody in the Gould & Curry mine, possibly a north extension of the huge body of mill ore developed in the Savage, adjoining at the south. This work will be conducted between the horizon of the Hale & Norcross tunnel and the 882-ft. level of the "inside" shaft of the Arizona-Comstock Corporation, operating the middle-mines group: Savage, Hale & Norcross, Chollar and Potosi. The tunnel company has blocked out an estimated 1,000,000 tons of mill-grade ore in its Crown Point mine, farther south on the lode.

Below Gold Hill, and beyond the "split" in the Comstock lode, the new 50-ton test mill at the Overman shaft is near completion, equipped with jaw crusher, Hardinge ball mill, classifier, plates and Kraut flotation cells. Mine work is confined to the 1,100-ft. level, where a southeast drift on the Silver City fracture is being driven to connect with old workings from the long-abandoned New York shaft. A new "CN" compressor has just been installed at the shaft.

A 50-ton mill unit, with Hardinge ball mill, plates, and concentrating tables, is being constructed by the Weepah-Horton Company, at Weepah, west of Tonopah. Another unit of similar design will soon be completed by the Gilbert Brothers, at Gilbert, the scene of their discovery of about ten years ago. Several small units are in process or prospect of construction at various points in Nevada. The first 50-ton flotation unit at Rosebud Canyon, Pershing County, will be turned over early in August.

Arizona

The Nellie Meda mine, 8 miles north of Aguila, has been acquired by Wenden Copper. Three located claims and a fraction comprise the group, which has been operated intermittently by hand methods for a number of years. When the Wenden company obtained control, the property had two shafts 125 ft. deep, from which a number of short drifts had been driven, both shafts and drifts being on the contact between a diabase dike and granite. Since the first of June, one of the shafts has been deepened to a depth of 200 ft. and drifting along the contact, which pitches at 70 deg., has been started. The vein on the contact is 7 ft. wide. Two feet on the hanging wall carry a substantial amount of gold per ton, the values decreasing toward the footwall. Machinery at the property consists of a 16-hp. West Coast gas engine and hoist and a 1,700-lb. capacity bucket; a small Ingersoll-Rand compressor, connected to an automobile engine; an I-R stoper, and four Chicago Pneumatic pluggers. If sufficient ore is found, the Wenden company plans to move a 260-hp. Buckeye diesel engine, a General Electric generator, and an Allis-Chalmers double-drum, electric hoist to the Nellie Meda from the idle Wenden copper mine, at Wenden.

At Tombstone, a steel head frame has been placed over the Empire shaft of the Bunker Hill mines, and the shaft is being retimbered. Between 60 and 70 leasers are at work on the property. At the Tombstone Extension, American Smelting & Refining is doing development work on day shift, and is sinking the shaft on the other two shifts. Sinking has progressed nearly to the 485-ft. level, which will be the bottom level for the present. At the South Bonanza claim on the Mellgren property, leasers have installed a hoist and compressor, and have built some mine buildings. Altogether, about 150 men are working in the mines of the Tombstone district.

The Big Jim mine, at Oatman, is sending 50 tons of ore per day to the Telluride mill, which is operated under lease. C. & B. Mining, which is operating the Big Jim, is also arranging to develop the Oro Grande, the Oro Flamme, and the Sterling mines, in Yavapai County, and the Tintic, at Chloride. Water in the Tom Reed mine, at Oatman, has been lowered below the 1,100 level, and the company has let contracts to L. V. Hautier for driving drifts on that level and the 950 level. Including miners, muckers, pumpmen, and hoistmen, 28 men are employed in the mine.

A 150-ton capacity ball mill is being installed at the Gold Leaf mine, at Wenden. Development of the mine was started in October, 1932, and since that time a 1½ compartment shaft has been sunk 125 ft. and 200 ft. of drifting has been done.

Utah

Shipments of gold ore are being made from the 1,100-ft. level of the Bingham Metals Mining property at Bingham. Width of the vein varies from 1½ to 3 ft.

About 3,000 tons of ore is being shipped monthly from the 400 level of the Utah Metal & Tunnel mine, at Bingham, to the Garfield smelter of American Smelting & Refining. Gold is the predominating valuable metal in the ore.

Montana

Quite a number of Montana mining properties, according to reports, have been withholding shipments of gold ore until they received further information in regard to the right of gold miners to sell their ore in foreign or free markets. Basin Goldfields will ship two carloads of high-grade ore as soon as the question is settled.

Canada

Siscoe Gold Mines is milling 300 tons a day and recovering between $11 and $12 a ton, plus exchange compensation. The company's policy is to mill ore that formerly was left in the mine, but the rising price of gold has tended to keep the value per ton recovered at about its former level of $15, Canadian funds.

Mill capacity of Beattie Gold Mines is to be increased from 550 to 750 tons a day by the addition of regrinding equipment. With this addition estimated costs are $2.75 a ton. In June the recovery in the concentrates was $3.68 from $4.40 ore. Present mill results indicate that, with a second milling unit, costs will be reduced to $2.25 a ton. Howey, Ontario's low-cost gold mine, recovered $3.45 per ton in bullion at a cost of $2.30 in its 900-ton mill, for the quarter ended June 30.

Consolidated Mining & Smelting has acquired a large acreage in Whitney Township, northeast of the producing mines of the Porcupine camp, where small amounts of gold ore were formerly developed on the Three Nations, La Palme, and Porcupine Grande properties. The Three Nations shaft is being deepened from 250 to 500 ft., with a view to a thorough search for larger deposits of ore within the extensive mineralized zone.

The Michipicoten district, north of Lake Superior, promises to produce its first substantial gold mine at the Michael-Boyle property, east of Goudreau station. A fine surface showing found three years ago was examined by adit and diamond drilling, but no underground extension of the vein was found. A year ago, Dr. Paul Armstrong, of Montreal, studied the deposit and decided that faulting had concealed the vein in an unusual way. Diamond drilling conducted by Coniagas during recent months has traced this concealed portion of the vein for a length of over 2,000 ft. to a depth of 300 ft.

In the Bridge River district, developments at the Bralorne mine continue to be remarkably gratifying, another large orebody having been encountered last month from a drift on the seventh level. Milling is meanwhile being maintained at the rate of about 130 tons daily, but additional power machinery and other equipment are being installed for the purpose of increasing the milling capacity to 200 tons during the next four months.

Africa

Tanganyika Concessions, with its associated companies Zambesia Exploring and Rhodesia-Katanga, has paid the £5,000 necessary to retain its option for a year longer on control of the Eldoret Mining Syndicate's large holdings in the Kakamega gold field, in Kenya, Africa. It has also accepted the Kenya government's offer of a concession over 1,550 square miles in Northern Kavirondo.

Recent reports state that nearly all of the alluvial gold in the vicinity of the reef outcrops in the Kakamega field has been recovered, but some engineers believe that further considerable amounts will be obtained by dredging the rivers and streams in the vicinity. Production of reef gold, though still small, is increasing. It amounted to 136 oz. in March and 232 oz. in April, and, of alluvial gold, 408 oz. and 268 oz. in the two months, respectively. Elsewhere in Kenya 453 oz. was produced. Though optimism concerning the future of Kakamega and the surrounding area seemed on the wane a while ago, it is evidently now reviving. Opinion is growing that Kenya has a future as a producer of gold.

Australasia

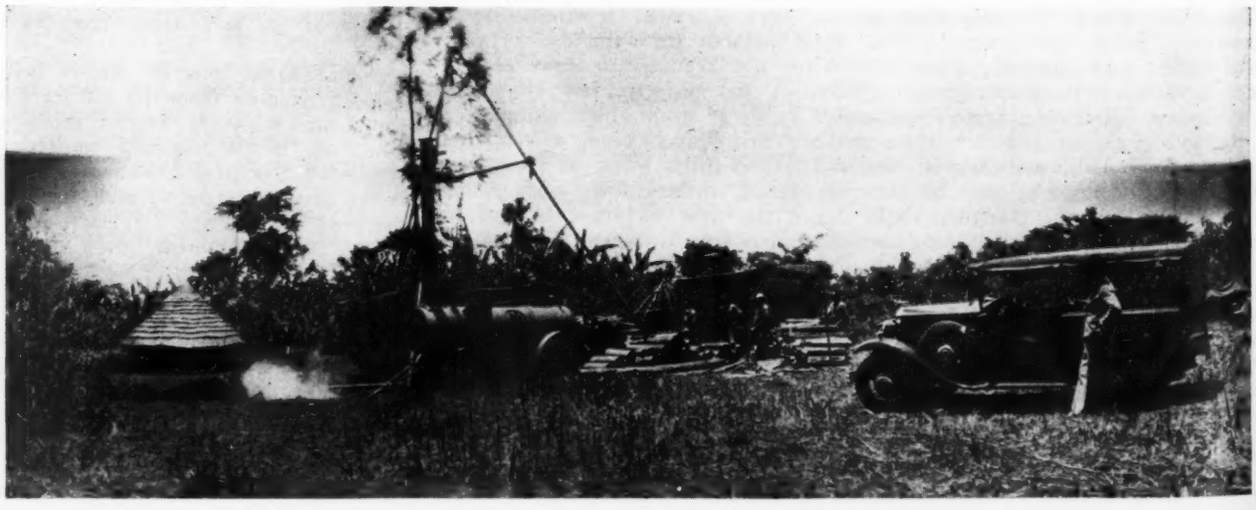
Bululo Gold Dredging, New Guinea, has announced that the total payment of shares to be made to its parent organization Placer Development, in respect of the purchase of the Bulowat and Burnside areas, will not exceed £235,000. The total wash available for dredging exceeds 100,000,000 cu.yd., from which the company expects a profit of 23,250,000 gold dollars. These profits will probably be won over the next eleven years. Further boring will possibly result in additional wash being added to the present reserve figure. The company now has two dredges in operation on the Bululo leases. These machines are recovering 12,000 oz. monthly from 490,000 cu.yd. No. 3 dredge, on the new area, will be in production at the close of the year, and is expected to dig 3,000,000 cu.yd. monthly. The fourth dredge will be in operation seven months later than No. 3.

Bululo Gold Deposits has commenced equipping its sluicing area at the junction of the Koranga Creek and Bululo River, New Guinea. Large piping, 18 in. and 22 in. diameter, will be used, and 100,000 cu.yd. will be treated monthly.

Broken Hill Pty. has announced that boring operations on the alluvial gold area on the Gwydir River, N.S.W., have been unsatisfactory. A second area at the Macquarie River is still being tested. The company has commenced operations on the Hannan's Extended mine, Kalgoorlie, the treatment plant having a capacity of 1,200 tons monthly.

Boulder Perseverance, Kalgoorlie, reports that the new bromo cyanide plant, with a capacity of 7,500 tons monthly, is giving an extraction of 93 per cent, with costs 6s. per ton less than by the old method.

Diamond drilling on the Kakamega gold field of Tanganyika Concessions in Kenya Colony, Africa. In conjunction with Zambesia Exploring Company and Rhodesia-Katanga Company, Tanganyike Concessions holds a purchase option on the controlling interest in the Eldoret Mining Syndicate. The syndicate has a concession that covers 35 square miles in the Kakamega district, and owns 165 reef claims and 152 alluvial claims outside the concession. Owing to promising discoveries, Tanganyika Concessions has applied for exclusive prospecting right on an adjoining area of about 6,000 square miles.



Industrial Awakening Increases In Mining Districts

Further Evidence of Improved Conditions Is Seen in the Continued Expansion of Operations and the Adoption of Wage Levels Mentioned in the NRA Agreement

CONTINUED expansion in mining, milling, and smelting activity, with the inception of numerous new enterprises, characterized reports from the various mining districts for the last month, as indicated in the paragraphs that follow. Cooperation with the Government in applying the provisions of the NRA agreement prevailed generally, and strenuous efforts were directed toward the preparation and adoption of codes for presentation to the Administration. Workers organized in some districts, and local groups affiliated with national organizations.

Employers in the zinc industry were authorized by General Johnson on Aug. 3 to display the Blue Eagle of the NRA upon complying with the labor provisions of the code of fair competition for the zinc industry, substituting these for the corresponding provisions of the President's reemployment agreement. The zinc code provides for a maximum week of 42 hours and for minimum hourly wages of 30c. to 39c. It covers all branches of the industry, including mining; Prime Western, High-Grade, and secondary-zinc operations; rolled zinc, zinc oxide, lithopone, and sulphuric acid production.

A basic code for the lead industry, covering hours and wages of labor, was filed by the Lead Industries Association on Aug. 3. The code was filed on behalf of lead producers and the manufacturers of lead products.

. . . CALIFORNIA

WORK IS PROGRESSING favorably at the Canada Hill mine of Western Mines Corporation, near Nevada City, where the old 1,500-ft. Charronnat shaft is being unwatered and reconditioned preparatory to extensive development of the property. About 800 ft. of the incline shaft has been recovered and repaired, and opening of new ground in the upper workings is in progress. The company is also interested in development of the Ragon, Anchu, Erie, and other properties in the Nevada City area.

SHAFT SINKING OPERATIONS in the Empress mine, near Grass Valley, passed the 1,000-ft. level, completing the objective set by the management. The shaft has been sunk 900 ft. in the last two years, with no diminution of the ore values encountered in the upper levels. Plans are maturing for the installation of a reduction plant of enlarged capacity.

A 100-TON MILL is to be erected at the Pilgrim mine, near Alleghany. The Pilgrim claims cover 343 acres in the vicinity of the well-known Sixteen-to-One mine.

DRIVING OF A NEW TUNNEL to develop the downward extension of the vein-system in the Zeibright mine, near Emigrant Gap, is to be undertaken, and the old mill reconditioned and placed in operation. A substantial tonnage of low-grade ore is said to be available in the old workings reconditioned recently. The mill will treat 35 tons a day. The Zeibright mine is controlled by Newmont Mining.

WORK HAS BEEN RESUMED at the tungsten mine of Atolia Mining, near Randsburg, where the mill is being reconditioned for early operation. A carload of concentrates taken out during the course of development work on the 1,300-ft. level was shipped recently. Many former workmen are to be reemployed.

. . . ALASKA

GOLD MINING in Alaska is very active, with many new strikes at widely scattered localities. Many old properties are being surveyed with a view to bringing them back into production by modern economic methods.

FAIRBANKS EXPLORATION'S company's fleet of dredges started working this year about a month earlier than usual. Renewed interest has developed in the Nome beach placers, reports this winter stating that last season every man was making an average of $10 a day. The taking over of new ground by the Hammond Company insures steady operation, so it is estimated, for the next 50 years.

AT THE PROPERTY of Nabesna Mining, on Nabesna Creek, a branch of the upper Tanana River, in eastern Alaska, mine and mill are operating at capacity on exceptionally rich ore, with more reserves ahead than at any time in its history. New machinery, bought at Seattle and brought in by tractor last winter, was installed early this year. The first output of bullion and concentrate left the mine June 10 for the Tacoma smelter, being transported to Cordova via the new Slana road by caterpillar tractor to the Copper River & Northwestern R.R.

The new Kraut flotation plant thus far has been returning a higher grade of concentrates than factory tests predicted. In addition to tailing from present production this plant will also treat tailing accumulated during the past two years of operation. In the opinion of Manager Carl Witham, development during the past two years has opened reserve ore sufficient to warrant a doubling of the milling capacity during the coming year.

Last year, with about 20 men in the crew, the old mill ran about 700 hours, treating between 1½ and 2 tons an hour. Mill heads averaged $90 a ton. Tunnel work totaled 452 ft., and the Bear vein was tapped 162 ft. below the main tunnel level. The new drift was in ore for its full distance, the vein width being 1 to 6 ft. Manager Witham plans to operate the plant this year at triple the running time of last year.

THE FIRST MODERN DREDGE to be installed in the Fortymile district, Alaska, is being constructed at the Washington Iron Works, at Seattle, for Walker's Fork Gold Corporation, whose property is situated at Walker's Fork, on upper Fortymile River. The big dredge is of combination screen and flume type, with a daily capacity of 3,000 cu.yd., and construction is being rushed to deliver it at Dawson before freeze-up this fall. It will then be hauled 52 miles to the property by tractor during the winter, so as to be installed and ready for operation about May 15, 1934.

The company owns 112 claims covering 14 miles of the river, with 3 miles of ditch and flume, giving ample water. It has been in production by hydraulic, with a small scraping plant, for the past five years.

Tests on the company ground show 8 ft. of pay gravel under a 4-ft. overburden of muck. About a mile of this overburden has been washed off by hydraulic giants, leaving the gravel clean and ready for dredging operations. Only about a half mile of the prepared ground has been worked by the hydraulic-scraper method.

The Fortymile district is one of the oldest in Alaska, and antedates the Klondike discoveries. Three other placer properties are now being tested with a view to installing modern dredges.

. . . NEVADA

IN THE CANYON above Silver City, at the southern end of the Comstock district, the old Keystone mine continues shipping 10 to 15 tons per day to the Donovan mill at Silver City. By simple amalgamation, this mill recovers 94 per cent of the gold content of the Keystone ore. . . . Below Silver City, men have been engaged in sampling the Dayton mine, in which the orebody is said to range from 20 to 40 ft. wide. If C. N. Miller, of San Francisco, who has a short-time option, secures the Dayton, he will dismantle the Flowery mill, below Virginia City, in Six-Mile Canyon, and move it to a point below the Dayton.

DEEPER WORK may be undertaken in

the Tonopah Divide mine, which produced over $2,000,000, principally in silver. Scott Jameson, a Tonopah mining man, working a lease, has opened 18 in. of high-grade gold-silver ore on the 800-ft. level, far south of the shaft.

DEVELOPMENT at the property of the Mountain City Copper, at Mountain City, has been turned from the 400- to the 250-ft. level, because a heavy flow of water has been struck on the lower level. Work will be centered on the opening up of the shoot, which, on the upper level of the mine, produced a considerable tonnage of high-grade copper ore.

ONE CHURN DRILL HOLE has been put down 129 ft. at Lime Mountain, where development is being conducted to prove a sufficient tonnage of gold ore for the erection of a mill. Progress of drilling, according to reports, has been averaging about 25 ft. daily.

. . . IDAHO

BUNKER HILL & SULLIVAN Mining & Concentrating, operating at Kellogg, announced the discovery of a large body of silver-lead-zinc ore in the Blue Bird claim, on Milo Creek. Exploration operations had been in progress for several months prior to the uncovering of the orebody on the 1,000-ft. level, which is believed to extend to the 2,000-ft. level. The orebody averages 100 ft. in width, and is about 1,000 ft. long. Although of low grade, it is said to be the most important discovery in the Cœur d'Alene region for many years.

YELLOW PINE MINING, a Bradley subsidiary, is reported to have resumed milling operations at its mine near Stibnite, in Valley County. The 200-ton mill is equipped for differential flotation and for roasting and cyaniding the wet concentrates.

. . . UTAH

STEEL WORK of the new lead refinery being constructed at Midvale by United States Smelting, Refining & Mining has been erected, and corrugated sheet-iron and brick work is being completed. Furnaces are being built and other permanent equipment is being installed, preliminary to the beginning of operations on Sept. 1.

SHIPMENTS at the Yankee Mines of American Smelting & Refining have been temporarily suspended while development is being done.

. . . MINNESOTA

IRON-ORE MINING NEWS is particularly good this month. As the steel activities increase around Lake Erie, so do the estimates of iron ore shipments for this season. The prediction a month ago was twelve million tons, and it has now increased to twenty-one million. A majority of the open-pit mines are in production, and several underground properties are getting in condition to start hoisting ore. Labor around the mines, which has been living on so little the last two years, is feeling much better and willing to join with the operators in any scheme of improvement that may lead to permanent employment and a living wage for all.

REPUBLIC STEEL is showing the most activity, as it took over the Alexandria mine, formerly operated by Cleveland-Cliffs, on July 1, and is shipping the stockpile. It has drained the underground workings, and started hoisting on Aug. 1. The Susquehanna mine, taken over Jan. 1 from M. A. Hanna, is also being prepared for shipments, which are to start soon. Butler Bros, are shipping from the Patric, Harrison, and also from the Margaret mine, near Buhl. Jones & Laughlin is operating the Hill Annex mine, which was idle for two seasons. Cleveland-Cliffs started the Canisteo and Drew mines a few days ago. Everyone is hoping that this activity is not a mere flash in the pan, but that it means a start to permanent recovery. With most of the mines stripped, the operators can readily provide the Eastern mills with all the iron ore demanded.

. . . MICHIGAN

WITH THE ADVANCE in the price of copper to 9c. a pound, a more optimistic view of the future of the industry is taken in the Michigan district. On the present scale of wages and the high yield of copper rock mined, the two operating companies, Calumet & Hecla and Copper Range, can make a profit on new metal. A higher price for copper, however, would enable the payment of better wages and the mining of average grades of ore.

CALUMET & HECLA has no development costs, mining being confined to rich rock in the pillars and backs of old stopes in the upper levels of the conglomerate shafts. Also, a big slash has been made in overhead, and electrification, replacing steam, is in progress. Money has been saved in every department, and costs are the lowest in years.

COPPER HAS BEEN MOVING in large volume, and stocks are being rapidly lowered. Copper Range has a market for all it can produce at the present rate, the bulk of its metal being shipped to C. G. Hussey & Company, Pittsburgh fabricators, which is controlled by the Copper Range Company.

THE COPPER COMPANIES will have a lighter tax burden now that a 15-mil tax limitation amendment is in effect in Michigan. This amendment brought about a substantial reduction in taxes, the State having applied a general sales tax to make up the difference. The State Legislature will probably meet later this year in special session, to provide relief for the public schools of the State. Reduction in taxes and adoption of every form of economy in operating will permit the mining companies in the future to make a profit at a market price far lower than has ever been known prior to 1931.

RECENT WAGE INCREASES by Calumet & Hecla and Copper Range reflect not only the improvement in the metal market but are regarded also as an indication of the industry's desire to cooperate with the National Recovery Administration. Neither company will increase production. Calumet & Hecla's increase of 40c. per day, for men receiving $30 a week or less, and the Copper Range advance of 35 to 40c. daily, will prove beneficial to the district generally, inasmuch as it is largely dependent on the copper industry. The Copper Range company has been working six days a week on a two-shift basis, but the new basis of operations will be five days a week, with three shifts daily. This will permit employment of a small number of additional men, the company having added 60 to its payroll.

. . . ARIZONA

IMPROVEMENT in the copper situation led to resumption of operations at the Douglas smelter of the Phelps Dodge Corporation on July 17. The plant had been shut down late in May and was to have been closed down until September. About 285 men will be given employment on a restricted basis. At the mines at Bisbee, the 900 men now at work will gain additional employment by the establishment of a five-day week.

. . . MONTANA

ANACONDA COPPER MINING, according to reports, has received a large contract for zinc. The Emma mine of its subsidiary, Butte Copper & Zinc, is expected to be in production before the end of August and will probably have an output of about 300 tons per day of 14 per cent zinc ore.

. . . CANADA

A SECOND SILVER AREA in the Great Bear Lake district has been outlined at Camsell River, about 60 miles south of Labine Point, where the original silver-radium finds were made. White Eagle Mines has been organized to develop the area, and has sent in a gasoline-driven mining plant, fuel being available locally from the Fort Norman refinery of Imperial Oil.

NORMETAL MINING, which owns the Abana mine, in northwestern Quebec, and is under the control and direction of Mining Corporation, has announced that it will complete immediately the concentrator left unfinished by the former owners, and double its capacity to 500 tons. Between 600,000 and 700,000 tons of zinc-copper-gold-silver ore has been developed down to 550 ft.

Falconbridge Nickel's new concentrator has permitted mine production to be raised to 750 tons a day, 200 tons of which goes to the mill, the remainder being sent direct to the smelter.

A NUMBER OF OLD MINES in various sections of British Columbia have been

Remains of a 120-hp. Cornish condensing engine used to pump mine water at the Vaucluse gold mine, near Fredericksburg, Va. The property was actively worked about the middle of the last century, and as early as 1847 an elaborate milling plant for the separation of gold from quartz and pyrite was in operation at the mine.

acquired by syndicates and corporations, and are being reopened. Among these are the Brooklyn-Stemwinder, in the Boundary district, formerly owned by Dominion Copper, of Boston, which between 1904 and 1908 produced about 272,150 tons of copper ore that carried an appreciable amount of gold. Another such property is the Combination, near Greenwood; and at another, the Jewel, a gold property which was formerly profitably operated, the mill is being reconditioned for the resumption of operations. In the Beaverdell camp, in this area, financial arrangements have been made for the reopening and operation of the Sally mine, and work has also been resumed at the Beaver. From the old Morning Star mine, in the Fairview camp, which was recently acquired by an adequately financed company, shipments of ore from development are already being made to the smelter.

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Trepca Mines Inspires Interest in Old Serbian Properties

The remarkable results achieved by Trepca Mines is expected to cause activities to begin on several other of the properties similarly marked by old workings in Serbia before the year ends. One property, that of Zletovo Mines, had developed up to the end of last year 632,000 tons of high-grade lead-silver ore, with low zinc values; and development had been confined to one of several ore occurrences.

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New Mill at San Miguel Mine

A 30-ton flotation plant is being built by Cia. Minera del Monte, at the old San Miguel mine, near Taxco, Guerrero State, which property the company recently acquired and opened up after it had lain idle since 1911. Explorations show that the mine, which is being unwatered, can produce sufficient ore daily to keep the plant in steady operation.

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Machinery Manufacturers Organize Institute

Organized to coordinate and represent the interests of machinery manufacturers in relation to the National Recovery Administration, the Machinery and Allied Products Institute offers a medium through which the makers of mining and metallurgical equipment can gain the advantages of united action in the present emergency. The Institute is a federation of trade associations, already numbering among its members the manufacturers of ore and rock crushers and air compressors. The membership of other organized groups serving the mining industry is invited. Assistance will be given in organizing new trade associations or in directing manufacturers to appropriate existing agencies for group action.

Information regarding the Institute can be obtained from John W. O'Leary, president, 221 N. LaSalle St., Chicago, Ill. Mr. O'Leary is past president of the Chamber of Commerce of the United States and of the Chicago Association of Commerce. Other officers of the Institute are: vice-president, Harry C. Beaver, Worthington Pump & Machinery Corporation; secretary, Paul C. DeWolf, Brown & Sharpe Manufacturing Company; treasurer, Robert H. Morse, Fairbanks, Morse & Company. Among others participating in the organization of the Institute were representatives of Allis-Chalmers Manufacturing Company, Gardner-Denver Corporation, Ingersoll-Rand Company, Link-Belt Company, Nordberg Manufacturing Company, Sullivan Machinery Company, Traylor Engineering & Manufacturing Company.

Gold Ore and Concentrate May Be Exported

Unless stabilization of the dollar is undertaken in the very near future, close observers of the gold situation are reported to be practically certain that newly mined gold will be allowed to have the benefit of the world price. Discussion of the subject long since made clear to officials in Washington that only negligible benefits would come to the people, as a whole, by requiring gold miners to sell their product for $20.67 an ounce and that, on the other hand, such action would practically close down an industry, with resultant unemployment and the loss of gold production.

The belief prevails that an opinion was sought from the Attorney General more for the purpose of determining whether or not the Executive order must be modified. In the event of modification the desire was to have all of the legal points straight, so that the amendment would open the door to newly mined gold only. From the standpoint of national policy only $30,000,000 or $40,000,000 would be involved. No one expects stabilization of the currency to be postponed for an entire year, so that only part of a year's production would enter into the calculation.

Attention of officials in Washington was also directed to the fact that those who had to give up their gold constituted a very small percentage of the population. Even then their loss was small, as at the time the Executive order was issued no material increase in prices had taken place.

At this writing, the opinion of the Attorney General has not been made public. The fact was revealed, however, that smelted or imperfectly refined gold is definitely barred from export, but that gold ore and gold concentrate which has undergone no processing may be exported. Inasmuch as the export of any significant amount of gold in the form of ore or concentrate would be impractical, the opinion is of little value to the industry, but the general belief is that the opinion was sought simply to determine the scope of the existing Executive order.

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Two Canadian Companies Announce Increase in Wages

Consolidated Mining & Smelting and Granby Consolidated announced wage increases during July. Consolidated restored its rate to the level obtaining before the last 5 per cent reduction, and Granby announced an increase of 10 per cent. At the Consolidated company's Sullivan mine, operations are on the basis of six days a week, as compared with the former arrangement of alternate weeks of four and five days.

Personal Notes·Comment·Criticism

N. S. Erleigh has left Johannesburg for England.

Merle Guise is drilling on a Snake River bar at American Falls, Idaho.

A. L. Blomfield is managing director of Lake Shore Gold Mines, Ltd., at Kirkland Lake, Ontario.

Ira B. Joralemon, consulting geologist, has returned to San Francisco from British Columbia.

Lawrence Scotland has been appointed joint assistant managing director of Tanganyika Concessions, Ltd.

W. Gemmill, general manager of the Transvaal Chamber of Mines, recently left for Bechuanaland and the North.

Carl J. Trauerman, of Butte, has been elected a vice-president of the Northwest Executive Engineers, Inc., of Seattle.

A. S. Rome, manager of the Rezende Mines, Penhalonga, Valley, Southern Rhodesia, has been on a visit to Johannesburg.

Max Kraut, mining and metallurgical engineer, Pan-American Engineering Corporation, San Francisco, has left for Bulolo, New Guinea.

Livingston Wernecke, general superintendent of Treadwell Yukon Company, Ltd., has returned to San Francisco from a business trip to the East.

E. W. (Ted) Stull is conducting the air service for Canadian Airways from Norway House to Island Lake, in northern Manitoba.

L. G. Smith has gone to Camsell River, east of Great Bear Lake, to take charge of the development of the silver property of White Eagle Mines.

Duncan MacVichie, consulting engineer, is president and general manager of the Western Mining & Construction Company, Salt Lake, Utah.

Thomas G. Murdock, formerly with the Anglo Chilean Nitrate Corporation at its operations at Maria Elena, Chile, is now with the Cerro de Pasco Copper Mining Company at Morococha, Peru.

"Bob" Cockeram, who does most of the flying for Prospectors Airways, is at present at Great Bear Lake, having flown there from the company's headquarters at Haileybury, Ontario.

M. W. von Bernewitz, formerly with the *Mining and Scientific Press*, the "Mines Handbook," and the United States Bureau of Mines, has returned to New Zealand and Australia for an indefinite stay.

Stanly A. Easton has been appointed president of Bunker Hill & Sullivan Mining & Concentrating, succeeding the late F. W. Bradley. Mr. Easton has been vice-president and director of the company since 1926.

R. J. Jowsey, veteran prospector, who has returned to Toronto from a visit via the air route to the gold property of God's Lake Mines, of which he is president, reports interesting results from the first diamond-drill holes.

J. H. Cordner-James, W. H. Trewartha-James, and **Frank Merricks** represented the Institution of Mining & Metallurgy at the recent centenary celebration of the Royal Cornwall Polytechnic Society.

Henry C. Carlisle, chief engineer, Western Division, Tonopah Mining Company of Nevada, has returned to San Francisco from a six weeks' trip to Kirkland Lake, Ont., New York City, and Sonora, Mexico.

Dr. George Otis Smith has resigned as chairman of the Federal Power Commission. His successor is **Frank R. McNinch,** formerly vice-chairman of the Commission. **Basil Manly** assumes Mr. McNinch's position as vice-chairman.

Horace M. Albright, director of the National Park Service, has resigned, effective Aug. 9, to become vice-president and general manager of the United States Potash Company, operating mines and refineries at Carlsbad, N. M.

E. S. Bastin, of Chicago, has been elected president of the Society of Economic Geologists for 1933, and **D. H. McLaughlin,** of Cambridge, has been made secretary. **W. E. Wrather,** of Dallas, Tex., is the president-elect for 1934.

Ruel C. Warriner, formerly general manager of the Crown Mines, and, later, one of the consulting engineers of the Central Mining-Rand Mines' Group, who has been visiting the Witwatersrand, has left Africa on his return to Europe and America

J. Warrick, general manager of Great Boulder Proprietary Mines, Kalgoorlie, Western Australia, is in London for consultation with the company's directors and technical advisers in regard to the new flotation-cyanidation plant to be erected on the property.

Frank M. Kerr, well known in the mining districts of the West, recently was elected president of the Montana Power Company, succeeding the late John D. Ryan. Mr. Kerr has been with the Montana Power Company or its subsidiary companies since 1890.

R. W. Kerns, formerly of the general engineering department of American Smelting & Refining, and more recently in charge of smelter designs for Consolidated Coppermines, of Kimberly, Nev., is now located at Tucson, Ariz. His mail address is P. O. Box 657.

Fraser D. Reid, who mined out the famous silver deposits of Coniagas at Cobalt, has been appointed consulting engineer for Eldorado, and in July visited the company's silver-radium properties at Great Bear Lake. Mr. Reid has been elected president of the Ontario Mining Association for the current year.

Irvine M. Marshall, for five years superintendent at Central Manitoba Mines, in the Rice Lake mining division, northeast of Winnipeg, Manitoba, has assumed the direction of operations at the property of Reno Gold Mines, Ltd., in the Sheep Creek district of British Columbia.

C. A. Weekley, of Santa Cruz, Calif., until recently and for the past seven years concentrator superintendent for Andes Copper Mining Company, at Potrerillos, Chile, has sailed for Manila, via Japan and China, to assume the position of mill superintendent for Itogon Mining Company, Baguio, Philippine Islands.

John L. Middleton, who has been under treatment in Paris during the past year for recurrent fever contracted in Equatorial Africa while acting as Ingenieur Geologue and Chef de la Service de Prospection for the Cie. Equatoriale de Mines, is supervising the reopening, at the direction of French interests, of a gold mine in Yugoslavia, where a 40-ton pilot mill is being erected.

J. D. Tallant, formerly with Braden Copper and later with American Metal, will be general manager of Mufulira Copper Mines, Ltd., which will begin producing copper regularly, but on a restricted scale, about the beginning of the coming year. He is leaving London for Rhodesia, accompanied by **Arthur D. Storke,** managing director of the company.

P. R. Bradley has been elected president of Alaska Juneau, succeeding to the position held by his brother, the late F. W. Bradley, whose son, Worthen Bradley, becomes a member of the board, filling the vacancy caused by the death of his father. P. R. Bradley has also been elected president and a director of Treadwell Yukon, Alaska Mexican Gold Mining, Alaska Treadwell Gold Mining, and Alaska United Gold Mining, positions formerly held by F. W. Bradley.

John C. Pape writes from the St. George Gold Mines, Aracariguama, Sao Paulo, Brazil, that three of his contemporaries at the Royal School of Mines are now established in the State of Sao Paulo—**Axel Hethey,** formerly a metallurgist, now engaged in farming; **E. G. Dundas Wright,** mining engineer and international foot-baller, now with the Sao Paulo Railway company; and **José de Paiva Oliviera,** owner of zirconium mines and a hotel.

Influence of Mill Grinding on Floatability of Gold

The Editor:

In your issue for June, 1933, appears an elaborate and instructive article by Messrs. Oldright and Head, on the "Influence of Fine Grinding on the Floatability of Gold." The article was of great interest to me, as I have been for many years connected with enterprises concerned with the recovery of gold, though my experience has been largely with stamp-milling-amalgamation, and placer mining and dredging operations, and the attendant concentrating devices.

In ordinary stamp milling, where there is little or no base-metal sulphide, excepting only iron pyrite, I have not experienced the trouble which the treatise indicates, but have found that an ore when put through, say, a 40-mesh screen, and amalgamated, will, on recrushing the tailings, yield a considerable further amount of gold.

A recent test illustrates this: A sample of sand tailings, stamped through 40 mesh, was ground through 80 mesh, and amalgamated again, yielding $8.04 and giving 64c. tailings. A panning test on the material showed no concentrate at all. On this material the fine grinding evidently freed some gold which the coarser grind had left, either inclosed or attached to quartz, in such a way as to prevent its recovery. In placer mining there is also no base-metal sulphide to contend with, the usual "black sand" accompanying the gold being either magnetite or hematite, neither of which carries gold values and neither of which has contaminated the surfaces of the gold particles.

In placer-mining areas in California some of the gold is often found in what is called a "rusty" state, or is "greasy," the one from a coating of iron, the other from vegetable matter. I have also found the gold particles covered with a translucent enamel, which left an appearance of perfectly free gold, but these particles refused to amalgamate, even when rubbed into the mercury, unless the enamel was cracked or removed. In such cases the gold may be recovered by a jigging operation, which takes the heavy materials out of the sluices. The concentrate is then passed through ball mills, where it is polished by cobbles from the gravel being mined, and the resulting pulp is then passed over riffled tables, on which the gold is caught by mercury. Incidentally, there is a considerable recovery of platinum by this method.

Having been the instigator of this method of gold saving, and being the inventor of the "Neill jig" used in the operations on the dredges, I have naturally thought of its application to other phases of the industry. The suggestion contained in the "Conclusion No. 8" of the article—namely, the "bleeding" out of the circuit of a portion of the coarser material—had some time ago been suggested by me to the "Interests," but was not received with any enthusiasm. I suggested the introduction of a jig between the classifier and the ball mill, to handle the sand return, and sketched out the details and dimensions.

In this design it would have been necessary to jig the whole of the sand-return—a large amount of material. Hence the skepticism of the mill men. It is evident that there is no opportunity for a bleeding operation in the classifier itself, as the material therein is constantly stirred and mixed, and hence it would be necessary to dump the sand overflow from the classifier into a short launder or sluice, with suitable grade and water supply, in which the materials would have time to stratify, and the heavier to fall to the bottom. In this launder at a suitable point a slot would be cut across the launder bottom, and over this a thin steel cutting edge adjusted so as to skim or scalp out a layer of the material traveling along the floor of the launder. This knife edge would be adjustable to suit the conditions of the pulp, and the jig mechanism, as required. The material "bled" from the launder in this way would be sent over the jig or jigs; the tailings would be returned to the ball-mill circuit via the classifier; and the jig concentrates would be handled separately, either by direct tabling, or, if rich enough, in any other metallurgical manner. Under this arrangement only a portion of the classifier sand return would be jigged, and the installation would be much simpler.

On the California dredges the jigs are handling up to 16 cu.yd. per hour over a screen area of 11 sq.ft. The material has been screened through ¼-in. mesh, and hence it is probable that on the finer mesh of the mill return sands the capacity would be less. If we estimate this capacity at 1 ton per square foot per hour, and the standard size jig has 9 sq.ft., we can estimate the probabilities as follows: Say the sand-return on the ball mill is 480 tons per day, 20 tons per hour, and we bleed out ¼ of this, or 5 tons per hour, a quantity which one jig will readily handle. The amount of concentrate discharged by the jig can be regulated by the depth of the bed, which is composed of steel shot, and by the amount of under-water and complementary material, as in usual jigging.

On the dredges the operators use about 1.5 in. of iron shot, and take out about 1 ton per hour of concentrate. In fact, they take out as much as they can, as the quantity does not affect the operations and they do not want to miss any of the gold.

As an indication of what these jigs are doing, I can state that the material which goes to the jigs has first passed over riffled tables, which retain about 80 per cent of the values, and as the material mined carries about an average of 10c. per cubic yard, the jigs are getting a feed carrying about 1.5 to 2.5c. per ton. Nevertheless, the reports covering a period of months show that the jigs are saving an average of 8 per cent to the total clean-up of the dredges.

On one recent clean-up the dredge had evidently dug into a rich spot of rusty gold, as the jig clean-up amounted to 80 per cent plus of the total recovered. That was good insurance.

These figures indicate that the application of the general method, as suggested by Messrs. Oldright and Head, and elaborated herein, has a promise of usefulness in the recovery of baser minerals.

Pasadena, Calif. JAMES WILSON NEILL.

How Much Drill Steel Is Required Per Machine?

The Editor:

In the June issue of *Engineering and Mining Journal*, Mr. Geo. C. Riley questions my figures as to the amount of drill steel per drill consumed annually and required for circulation. If compared with averages for large districts, my figures may well be a little low, for in every district there are some mines where consumption is unnecessarily high, and my figures are based on records obtained at mines where distribution was not as complicated as at St. John del Rey or on the Rand, and where sharpening practice was excellent. The amount of steel consumed and required for circulation vary widely, according to the size and quality of the steel, the character of the ore, the methods of handling and sharpening, the time required to complete a circuit through the mine and shop, and the air pressure. The amount of steel required for circulation increases with the number of dulled bits and the breakage and with the time required for sharpening. Few accurate records of consumption over long periods have been kept, and as a consequence the data available on this subject are meager.

I have before me the record of drill-steel consumption at a large mine where the ore was unusually hard and large drill steel was needed. There were 65 3½-in. machines, using 1¼-in. hexagon hollow steel without lugs. For five years a record of machine-shifts worked, of all drill steel put in use, and of the number of bits sharpened was kept, and at the end of the period an inventory was taken of all steel in service. Some of the figures obtained are given below:

Drill steel consumed per drill per year (300 shifts), lb.	525
Drill steel in use per drill, lb.	888
Average number of bits sharpened per drill-shift	12
Loss per bit by sharpening and wear, lb.	0.088
Total loss per bit, including breakage and loss, lb.	0.147

The number of bits sharpened and the consumption of drill steel per ton of ore were reduced 45 per cent by improvements in the sharpening shop during this period, and the handling of steel was simplified. Dull steel was sharpened and returned to the miners in 24 hours.

These figures used as a basis for equipping and operating other mines have proved more than ample where equal care was used in sharpening and handling drill steel.

Milton, Mass. LUCIEN EATON.

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Appreciation

Frederick Worthen Bradley

To the youth of the country the life of Frederick Worthen Bradley is an inspiration. Mining men, engineers, and those interested in industrial enterprises will also find substantial encouragement in the rewards and successes that accrued to Bradley as a result of intelligent persistence, the courage to do, and the wholesome, well-rounded life he led. The mining industry was advanced by practices which he devised and applied and which proved successful in large-scale operations. Likewise labor, skilled and unskilled, technicians and engineers, and others, found gainful occupation as a result of the enterprises which he founded. The world's store of metals was increased by the product of his mines. Manufacturers found markets for their machinery in mills and mining plants. He was first of all a man of fine character, a leader in his chosen field, and all through his life a human, kindly man who appreciated his family, his friends, and his associates. He left a broad, straight trail glistening with good deeds, blazed by daring achievements, and most of it was through difficult and often untried ground. He was interested in others and spoke little of himself. He

worked for his stockholders and was not a money maker, but more a visualizer and creator.

Bradley was born in Nevada City, Calif. The early death of his father, Henry S. Bradley, compelled him to leave the mining college of the University of California before he had completed his course, and from that time until his death, on July 6, 1933, he was actively engaged in mining work. As a young man he showed unusual enterprise in taking over the old Spanish mine when it had failed and was unable to pay its workers. The mine was rehabilitated, the old debts were paid off, and it became a successful gold producer under his guidance. The attention attracted by this success brought recognition from other mining men, and Bradley was given the superintendency of the Bunker Hill & Sullivan mine, in Idaho, then and since one of the great mines of the country. The history of the Bunker Hill enterprise has been well told by Mr. T. A. Rickard. Bradley was president and managing director of the property throughout much of his lifetime. Labor trouble which almost cost Bradley his life, and strife with competing companies, proved the fighting spirit of the man. Later he rounded out the plant of the great mine by adding a modern smelter and still later an electrolytic zinc plant. He selected Stanly A. Easton as his operating manager and in the meantime occupied himself with the Alaska Treadwell group of mines, which he made one of the noteworthy gold producers of its time. Extensive caving and the inrush of sea water extinguished this group of mines in 1917. Another man might have been daunted by such a calamity, but it proved only an incident in Bradley's mining career. The Alaska Juneau property was his next objective. This property started out under what seemed to be suspicious circumstances. It had all of the earmarks of a great property, but Bradley and his associates of the time differed about organization policies. Illness caused Bradley to retire from his activities, and during the interval the property was equipped and started into production, but it was soon in difficulties and finally its future became dubious. A large debt accumulated. Bradley returned and with the able assistance of his brother, P. R. Bradley, he reorganized methods and equipment and then began a long fight to bring the property back to a profitable basis. This was successfully done, the debts were finally paid off in full, and the Alaska Juneau is now one of the important gold producers.

Bradley's mining activities covered a wide range. He was interested in quicksilver mining and developed and brought to production a number of properties in California and Nevada. For a long time his Atolia property made important petroleum production, but this phase of his work was a minor activity.

The closing period of Bradley's life was one of extraordinary activity. An exploration staff was organized. Numerous prospects were critically examined. Many were explored, and prospecting by airplane methods was tried out. He began with certain prospects in the Mayo district of the Yukon Territory. These were developed into successful mines, and, under Livingston Wernecke, became important producers, but they proved to be short lived. A silver-lead property was successfully developed at Tybo, Nev. Bradley was attracted to the Sudbury district, and after a costly diamond-drill exploration, he opened up a complex-ore property. The difficulties were unending. The metallurgical problem was worked out and the mill products were being marketed. Additional ore was developed, but Bradley was not satisfied. He was a courageous miner. The possibilities at depth intrigued him. There was justification for his optimism, for in other places in the Sudbury basin deep exploration had revealed immense orebodies of great value. He sunk a deep shaft and initiated at depth extensive exploration workings. While in the midst of this the depression arrived. Metal markets slumped. Uncertainty prevailed as to the future of the base metals. The Sudbury property went into temporary eclipse. The sources of capital dried up. Bradley did not quit. He turned his attention to gold properties. The resources of his organization were concentrated upon the problem of finding an important gold property. Idaho, Nevada, Canada, and California were combed. Wherever he went he placed miners at work under experienced direction. He built a mill at Bodie. He opened up the Yellowpine mine, in Idaho. At the time of his death he was operating four gold properties in California and one in Canada. Some of these are considered to be promising. Perhaps some one of these new mines will fulfill his hopes of placing the Treadwell Yukon in the ranks of dividend producers.

The four sons of Bradley are following in the footsteps of their father. During the last years of his life he placed his sons upon different properties, one at the Sulphur Bank quicksilver mine, and another at his Spanish mine, the ownership of which he retained. The two others are gaining mining experience at other properties. They all promise to be worthy mining men.

Bradley's home life was ideal. In large measure this was the secret of his outer success. He surrounded himself with family and friends. He was interested in his church. The mining students of the University of California partook of his liberality. When the pinch of adversity engendered by the depression affected his fortunes, at it did those of so many others, his principal concern was for the men whom he had gathered about him on his staff and for the workmen at his various properties. He stretched his resources to help many others, and in this he showed that unselfishness which characterized his whole life.

Frederick Worthen Bradley fairly deserves the position he attained. The Institute made him its president and gave him the Saunders medal. The University of California conferred the degree of Doctor of Laws upon him. In the hearts of his friends, however, he will be cherished for his manly, kindly qualities, and for the man that he was.

G. J. Y.

OBITUARY

Dr. Frank Robertson Van Horn, geologist; at Cleveland, Ohio, Aug. 1; aged 62.

Joseph Kentsmith, consulting metallurgist for Climax Molybdenum Company, recently at Battle Creek, Mich.

Charles W. Hanford, for more than twenty years associated with Ingersoll-Rand; in New York; aged 59.

William J. Elmendorf, long associated with the mining industries of the Northwest; at Seattle on June 26; aged 67.

Pentecost Mitchell, former president of the Oliver Iron Mining Company, of Duluth, Minn., subsidiary of the United States Steel Corporation; at Santa Barbara, Calif.; on July 17; aged 71.

Rodolphe Louis Agassiz, grandson of Louis Agassiz, the naturalist; at Pride's Crossing, Mass., on July 31; aged 61. Mr. Agassiz was chairman of the board of the Calumet & Hecla Consolidated Copper Company.

George T. Jackson, mining engineer, who died recently in Seattle, Wash., former general manager of Alaska Gastineau and Chicagoff, had for years maintained an active interest in mining matters in the Northwest and in 1931 served as chairman of the North Pacific section of the A.I.M.E. Mr. Jackson was born in England and was 59 years old. He had been a subscriber of *E.&M.J.* for a quarter of a century.

John Murchison Sully, general manager of the Chino Mines in New Mexico, a subsidiary of Kennecott Copper; on July 15 at his home in Santa Rita, N. M., aged 65. Mr. Sully was born in Dedham, Mass., and was graduated from Massachusetts Institute of Technology in 1888 as a mining engineer. After service with various mining concerns in the East and Middle West, he became general manager of the Chino Mines in 1909. He was a regent of the New Mexico School of Mines and a member of the American Institute of Mining and Metallurgical Engineers, the Mining and Metallurgical Society of America, and the American Mining Congress.

R. Gilman Brown, an American mining engineer and director who had resided and practiced in London for many years, past president of the Institution of Mining & Metallurgy; in London on July 6, after an operation for appendicitis; aged 69. Education at the Phillips Academy, Andover, Mass., at Dartmouth College, and at the Columbia School of Mines was followed by professional work with Chicago & Aurora Smelting & Refining, Aurora, Ill.; the W. A. Clark interests in Butte, Mont.; Standard Consolidated Mining, Bodie, Calif., and by consulting work in Honduras, Mexico, the United States and British Columbia, and the direction of operations of Brunswick Consolidated Gold Mining, Grass Valley, Calif., 1899-1906. In recent years Mr. Brown served as a member of the technical committee of Mining Trust, Ltd., in association with Leslie Urquhart, and as director of that corporation, as well as of Mining Trust of Northern Rhodesia and Russo-Asiatic Consolidated. Mr. Brown was elected president of the Institution of Mining & Metallurgy for the year 1923-24.

BOOK REVIEWS

How to Get a Job

THE TECHNICAL MAN SELLS HIS SERVICES. *By Edward Hurst. New York: McGraw-Hill Book Company. Pp. 239; $2.*

The purpose of this book is to aid college graduates, particularly the technically trained, in seeking employment. For more than eighteen years the author has helped graduates to secure positions, and this volume is based on an analytical record of results, successful and otherwise, which was kept during the period of that experience. General factors of the job-finding problem, such as contacting employer prospects and interview technique, make up the first third of the book. In the remaining pages are presented the details of ten employment-seeking cases. These make interesting, as well as instructive, reading; incidentally, they also comprise an excellent, even though indirect, exposition of the merits of a technical education. To the engineering graduate confronted with the task of securing employment, the book should be invaluable

H. D. KEISER.

Geophysical Surveys

STUDIES OF GEOPHYSICAL METHODS, 1930; Memoir 170, *Geological Survey of Canada, Ottawa, 1932. Pp. 118, figs. 51. Price, 20c.*

Interest in the details of "case histories," rather than in the broader sweep of geophysical exploration, marks these studies, continuing the series undertaken four years ago and published under the same auspices as Memoir 165 in 1929 or 1930. In the main, the investigators are also the same, the names of A. S. Eve, D. A. Keys, L. Gilchrist, and A. H. Miller appearing in the table of contents as the authors of various articles.

The connection of Professors Eve and Keys with the Mammoth Cave experiments is already well known to readers of geophysical literature, so it is no surprise to find their report on this work in the leading position in the present memoir. In simple language they tell the story of the absorption of electro-magnetic waves by rock formations, and the bearing of this phenomenon on geophysical exploration by the electromagnetic methods. The apparatus used in conducting the work is described, as well as the steps by which they arrived at the conclusion that the effect of 500-cycle currents is reduced to half value at a depth of about 500 meters. Magnetic surveys on some Canadian properties, using Askania instruments, are explained, and efforts at determining the dip of magnetic dikes, and depth of overburden, are correlated with model experiments using bar magnets. The contribution of these two authors ends with a simple description of electromagnetic methods of exploration.

Professor Gilchrist details his work with the "central electrode" method, which is of his own devising, for determining ground resistivities. In this method he employs a circle of current electrodes around a central current electrode, taking his measurements at intermediate potential electrodes arranged along radii of the circle. In the reviewer's opinion this set-up may be advantageous in the examination of horizontal strata, but not in the study of vertical conducting bodies, such as ore deposits, to which Professor Gilchrist has attempted to apply it. Some of his conclusions as to the applicability of the method seem a little optimistic, in view of the data actually submitted in the report.

Some simple gravitational and magnetometric surveys are dealt with by A. H. Miller. Chromite and pyrite bodies and magnetic dikes were investigated, and both methods were used on the Hazeldean fault in the Pre-Cambrian. The work is well and briefly described, with only the minimum of mathematical formulæ necessary to follow the discussion.

Better proofreading should be insisted on in future publications of this sort by the authors of this memoir. Legends do not always agree exactly with what is shown in the figures and tables, and a few downright errors are to be found in text and tables. They are not serious, however, and the wary reader will readily catch them. The geophysicist will find in this memoir some interesting details of geophysical experimentation, albeit they are rather elementary. To the geologist, the mining engineer, and the layman, the surveys described will prove illuminating as to just how the geophysicist works when faced with a specific problem.

SHERWIN F. KELLY.

Data on Mines

THE MINES HANDBOOK. *Supplement No. 1 to Vol. XVIII. June, 1933. Mines Information Bureau Inc., 17 John St., New York. Paper covered. Pp. 38.*

This is the first of a series of supplements to the eighteenth issue of the Mines Handbook, which will be published at intervals of approximately two months in 1933 and one month in 1934, making 16 up to the end of the latter year. Each supplement will contain information regarding approximately 50 companies, chosen largely on a basis of public interest as evidenced by inquiries. Most companies will be fully described. Page size is the same as in the Handbook. Supplement No. 1 includes companies in the United States and abroad.

Phosphates and Nitrates

PHOSPHAT—NITRAT. *Dr. Otto Stutzer and Dr. W. Wetzel. Berlin: Verlag von Gebrüder Borntraeger. Pp. 390, with illustrations, maps, and tables.*

Detailed descriptions of all important deposits of phosphates and nitrates, two of the most important raw materials in the fertilizer industry, are given in this monograph, one in the series on the world's deposits of non-metallic minerals. The chapters on phosphates are based on a previous work by Doctor Stutzer, which has been revised and extended. Much new material has been added to the description of the Russian phosphate deposits, which are playing such an important part in the agricultural development of the Soviet Union.

Of the section on nitrate, written by Doctor Wetzel, the major part is devoted to the Chilean deposits, their genesis, extent, and exploitation. The various hypotheses explaining the origin of these deposits have been presented in tabulated form, with a brief outline of the characteristic features of each. In this connection, attention may be called to the omission of the interesting hypothesis recently presented by Bjarne Hofseth (*E.&M.J.*, Vol. 131, No. 10, May 25, 1931).

The volume, well illustrated, contains much useful statistical information on ore reserves, production, and consumption of the two minerals.

Publications Received

"Metal Resources of New Mexico and Their Economic Features." By S. G. Lasky and T. P. Wootton. Bulletin 7, New Mexico Bureau of Mines, Socorro, N. M. Pp. 178.

"Canadian Limestones for Building Purposes." By M. F. Goudge. Bulletin 733, Department of Mines, Ottawa. Price 30c.

"Performance of Propeller Fans." By A. I. Brown. Bulletin 77, Ohio State University, Columbus, Ohio. Price 25c. Pp. 34.

"Eastern Extension of Lupa Goldfield." By D. R. Grantham. Short Paper No. 11. Geological Survey Department, Tanganyika Territory. Dar es Salaam. Price 1s. Pp. 9.

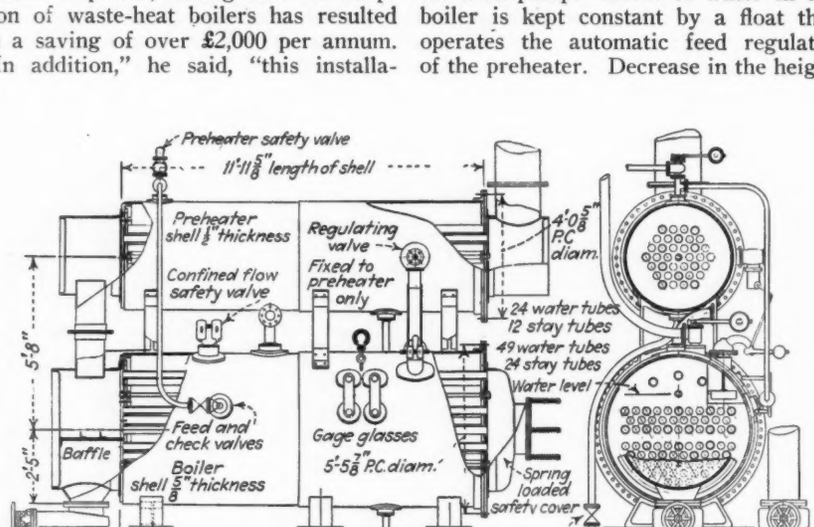
"Report of the Vermont State Geologist, 1931-1932." By George H. Perkins, State Geologist of Vermont. Free Press Printing Company, Burlington, Vt.

INDUSTRIAL PROGRESS

Waste-Heat Boilers Effect Fuel Saving

West Australian Plant Uses Producer Gas, From Wood

At the recent meeting in London of Sons of Gwalia, Ltd., operating in Western Australia, the chairman referred to improvements effected by the use of producer gas, from wood, as a source of power, adding that the adoption of waste-heat boilers has resulted in a saving of over £2,000 per annum. "In addition," he said, "this installation has greatly reduced the physical effort required of the firemen in the boiler plant operating the winding engine."



M.A.N. waste-heat recuperator at Sons of Gwalia power plant

A description of the first three of the waste-heat recuperators referred to, one for each of the NA4 Crossley-Premier gas engines, was given by V. T. Edquist, C. Valentine, and Norman Dunstan in a recently issued bulletin of the Institution of Mining & Metallurgy. The units, manufactured by the M.A.N. Company, of Nurnberg, Germany, are of the horizontal type, consisting of a boiler and preheater. Both are multi-tubular, the gas being split up into many thin streams, thus facilitating heat transfer. The tube nest of both shells can be withdrawn, so that cleaning may be conveniently performed.

Path of the gas through the recuperator may be traced by reference to the accompanying drawing. It may be passed to the boiler or to the atmosphere by means of hot-gas valves. The heating surface of each recuperator is 438 sq.ft.; that of the preheater, 216 sq.ft. The boilers are fitted with mountings common to other types; the preheater is fitted with safety and automatic feed-regulating valves, being at all times during operation under pressure from the feed pump. Level of water in the boiler is kept constant by a float that operates the automatic feed regulator of the preheater. Decrease in the height of the water line causes the float to fall, allowing the regulating valve to open and the feed to pass through the full preheater to the boiler. This method of controlling feed is efficient and reliable, according to the authors of the article. Almost all the attention needed is confined to the need for the engine-room attendant to keep the wall feed pump running at suitable speed for the load.

Hollow Drill Steel Improved

Greatly increased life, ascribed to improved methods of manufacture, especially to the manner of producing a smooth-walled hole, is credited to Swebo hollow drill steel, manufactured by the Bofors Steel Works, in Sweden, by the distributors, Svenska Export Aktiebolaget, of Stockholm. According to the latter, premature breakage of hollow drill steel must be attributed to cracks forming as a result of a rough hole surface, on the one hand, and to those forming as a result of corroding action of the flushing water, on the other. The first experiments to produce steel with a smooth bore gave improved results, but did not greatly increase the life. The problem resolved itself into devising means whereby the steel is protected from the effect of corrosive water, the formation and penetration of fatigue cracks is prevented or retarded, and indentations on the wall of the hole are avoided, or the tendency of such indentations to produce cracks and permit corrosion is nullified.

Five years ago the first cast of steel was made at the Bofors plant under the patent of F. F. Gordon, of Sheffield, England. Since then constant improvement is said to have been made. As made today, the steel has a bore, the surface of which is corrosion-proof, and is said to be otherwise superior with respect to fatigue strength and resistance to shock and vibration. Under the special method employed under the Gordon patent, the steel is cast so that it solidifies from the center as well as from the outside. As a result, no segregation of impurities takes place toward the center of the ingot, where the steel is required to be strongest.

Dry Concentrator Unique

A dry pneumatic concentrator having a capacity of 2 to 5 cu.yd. of gravel per hour is shown in Figs. 1 and 2. It is known as the Johnson machine and is owned by A. L. Firpo, 360 Elizabeth St., San Francisco, Calif. It is built of steel and said to be able to stand rough usage. It consists of a table 2 ft. wide and 12 ft. long, the surface of which is a series of steel plates (1) $\frac{1}{16}$ in. thick and overlapping each other about $1\frac{1}{2}$ in., and held apart by $\frac{1}{8}$-in. washers. Gravel is fed from a hopper by a pocket roll of new design. The pocket is as wide as the table, and the pulp is fed in an even layer the full width. Roll speed can be varied from nothing to full capacity while in motion, by moving a lever. Air is passed through a pipe and flexible hose into air pans (4) and then between the plates (1) in a line in which the pulp is traveling. In this way the fine values are not blown on top to be settled again or lost, and the air agitates the pulp over the full width of the table at every plate. Heavy particles settle as they pass down the table.

The concentrates are collected by means of two corrugated rolls (3)

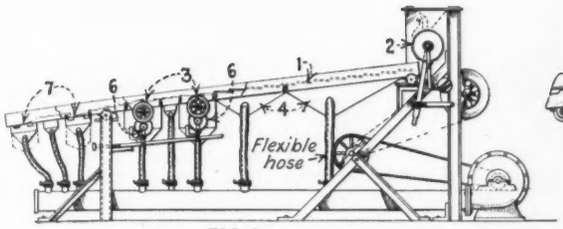


FIG. 1

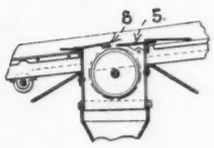


FIG. 2

Fig. 1—Elevation of dry pneumatic concentrator for handling gold gravel. Fig. 2—Detail of concentrate collection roll.

driven by a ratchet. Thus by varying the speed, the operator can take as much concentrate as desired. The collector works as follows: The heavy particles on passing plate (5) encounter a so-called retarding strip (8) and pass through the opening onto the collecting rolls and then into the hopper (6) to be discharged as concentrates. The lighter particles, and also the larger pieces, are worked up the inclined surface of the retarding strip and pass down the table to go into the tailings; or, in the case of nuggets too large to pass through the openings, to be caught by the nugget collectors (7). These consist of a set of inclined plates forming a pocket into which the air passes, keeping the material agitated. The table can be set to any desired pitch. It is pulled back and forth by a pitman having a variable stroke. Power required is about 5 hp.

Spectrographic Analysis

Where an assay for small quantities of impurities in refined gold and platinum is necessary, the usual chemical methods are costly and tedious on account of the relatively large amounts of material needed to obtain accurate results. In contrast, according to Adam Hilger, Ltd., London, England, the spectrographic method offers these advantages:

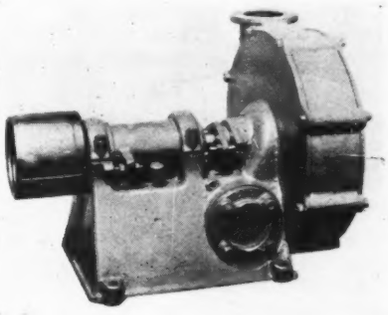
Very small quantities of the material are required and very minute amounts are consumed during the tests. A complete qualitative analysis is automatically recorded by the spectrogram. Exact quantitative analysis of alloy constituents is possible, subject to preliminary experimental work, which can, in most cases, establish basic data required for applying the method and provide standard alloys of known composition correlated with their spectra, for comparison with material, the composition of which must be determined. The method is also said to be most accurate for determining traces of impurities. Analyses can be made in about an hour.

Drip-proof Drives

A splash- and drip-proof motor and control for every machine requirement has been introduced in a new complete line by the Westinghouse company. This equipment is especially suited for wet grinding and similar service.

Fully Lined Sand Pump

A fully lined pump for handling sand and tailings that embodies various new features is shown in a cut. In it the suction is between the pump case proper and the driving unit. Because of this the only pressure on the packing gland is the incoming pressure from the source of supply. Thus the gland will be subject to very little wear. The pump case is box shaped with square shoulders. Inside it is a peripheral liner of a rounded shape which conforms to the shape of the volute in an ordinary centrifugal pump. This liner is held in place by set screws attached to removable outside housing. Two side-plate liners serve to protect the faces of the housing from wear. These are cast with grooves to fit closely the inside diameter of the peripheral liner. Both suction nozzle and discharge nozzle have renewable liners of abrasive resisting metals. The impeller is made of white iron or similar resistant metal and is cast with a soft core so that the latter may be threaded and the impeller screwed to the end of the shaft. Thus every part subject to wear is easily replaceable. To facilitate replacement, the outside casting flange is hinged. Moreover, the suction and discharge pipe line connections being attached to the main case of the pump, they need not be disturbed when making replacements. The runner is carried on ball bearings in oil. These take both side and radial thrust. This pump is made for either direct connection or for pulley drive. It is designed for relatively slow speeds and can be used for pumping against relatively high heads. It is made in various sizes and to accommodate almost any requirement in mining or milling operations.



Centrifugal pump of interesting design

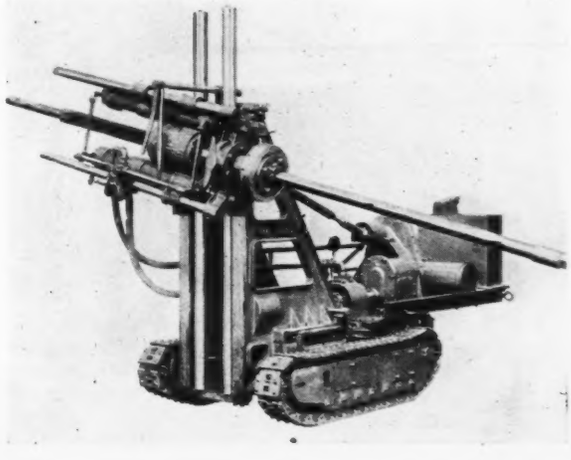
Record Anti-Friction Bearing

At the Century of Progress Exposition, the Timken Roller Bearing Co. of Canton, Ohio, is exhibiting what it claims is the largest anti-friction bearing ever made. The bearing weighs 3½ tons, has a capacity of eight million pounds, and is designed for use on the roll necks of steel mills.

The company is also exhibiting its recently developed detachable rock bit at the Exposition.

For Horizontal Drilling

In stripping work, the ability of a machine to drill deep holes horizontally can be turned to good account. Such practice spells economy in explosives, reduces the number of holes drilled and at the same time increases the drilling speed. It also makes it possible under certain conditions to select the formation in which the holes are to be drilled. Inasmuch as such drilling is wholly in rock, the use of casing to bedrock is eliminated. A machine known as the Stripborer which will drill holes of 6 in. diameter up to 100 ft. in depth is shown in an accompanying cut. It is made by Sullivan Machinery Co., Chi-

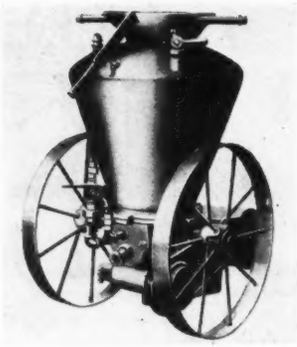


A deep-hole drill that has been found useful in stripping operations

cago. Its overall length is 12 ft. 5½ in., overall width 7 ft. 1 in. and overall height 7 ft. 5 in. The drill is crawler mounted and has a ground clearance between the treads of 14 in. It is powered with a 29-hp. gas engine or a 30-hp. electric motor, either a.c. or d.c. Net weight in pounds is 10,000 to 10,500.

New Nickel-Manganese Steel

A nickel-manganese steel having desirable properties has been developed by Taylor-Wharton Iron & Steel Co., as described by John Howe Hall, in a recent article which is distributed by the company. According to Mr. Hall, experiments were begun some years ago with the object of modifying the composition of manganese steel so that it could be made austenitic, strong, and tough by cooling in air after annealing, instead of by quenching in water, and so that there would be no embrittlement of the metal on subjecting it to temperatures of dark red heat. Fortunately both these qualities were found in a single metal which has the characteristic properties of standard manganese steel and a similar power of resisting heavy wear of many kinds, but, when heat-treated by a simple normalizing process, retains its strength and toughness after exposure to temperatures up to 1,120 deg. F. These properties have been secured by combining 3 to 5 per cent of nickel with the manganese of the standard Hadfield steel and at the same time lowering the carbon to about the eutectoid ratio so that there is little if any tendency to the separation of carbides on heating to low temperatures. This steel has a tensile strength of 97,000 to 105,500 lb. per sq.in. and a Brinell hardness of 170 in the finished ground form. It has a limit of proportionality of 27,500 lb. per sq.in. in tension and 31,000 lb. in compression. The test bar in rough form showed an elongation of 30 per cent in 2 in. and a reduction of area of 23.2 per cent. With the test bar in finish ground form, these figures were 56.9 and 48.3 respectively. In bending tests a rough ¾x¾-in. bar bent 180 deg.



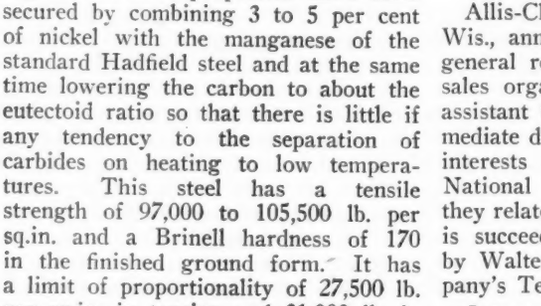
Another Machine for Applying Concrete Pneumatically

A new line of machines for applying concrete, cement-sand mixtures and refractory substances pneumatically has been introduced by the Gunitor Company, Elkhart, Ind. One of the units is shown in an illustration. Among the models is a one-man machine operated by electric motor and equipped with electrical remote control. This machine can be charged by one man and started or stopped from a remote position, as from a scaffold or wherever the point of application may be. Capacity ranges from 40 cu.ft. per hr. in small one-man machines to 250 cu.ft.

INDUSTRIAL NOTES

Allis-Chalmers Mfg. Co., Milwaukee, Wis., announces that L. W. Grothaus, general representative in charge of its sales organization, has been appointed assistant to the president with the immediate duty of directing the company's interests in matters pertaining to the National Industrial Recovery Act as they relate to commercial problems. He is succeeded as general representative by Walter Geist, inventor of the company's Tex-Rope drive.

International Nickel Co., Inc., has prepared a circular chart which shows at a glance the nickel-alloy-steel compositions and treatment required to develop yield points up to 175,000 lb. per sq.in. in section sizes varying from 1 to 12 in. These figures given are based on numerous tests and may be used as a general guide to the selection of steel.



At the Century of Progress Exposition

An exhibit of the Denver Equipment Co.

BULLETINS

Materials Handling. Link-Belt Co., Chicago, Ill. Souvenir book covering the Link-Belt display at the Century of Progress exhibition, Chicago. Pp. 48.

Steel. Joseph T. Ryerson & Sons, Inc., Chicago. Ryerson stock list or steel book for 91st year of company's steel service. Pp. 232.

Tractor Haulage. Linn Manufacturing Corp., Morris, N. Y. Catalog, entitled "Low Cost Haulage," covering Linn tractors. Pp. 16.

Rivet-Bolts. Dardelet Threadlock Corp., New York. Bulletin 11. Pp. 4.

Surge Protection. Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa. Catalog 38. Lightning arrestors and related equipment.

Refractories. McLeod & Henry Co., Troy, N. Y. Folder. "Steel Mixture Oil" firebrick for oil-fired furnace linings.

Steam Plant. Northern Equipment Co., Erie, Pa. Pamphlet. Copes double-control regulator. Pp. 8.

Motors. Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa. Folder. Splash-and-drip-proof drives. Pp. 4.

Grinding. Raymond Bros. Impact Pulverizer Co., Chicago. Bulletin. Model 28K air-drying pulverizers.

Electric Transmission. General Electric Co., Schenectady, N. Y. Bulletin GEA-1746. Glyptal-cloth-insulated cable.

Switches. General Electric Co., Schenectady, N. Y. Bulletin GEA-1761. CR 1061 switches for starting fractional horsepower motors.

Crushing. Allis-Chalmers Manufacturing Co., Milwaukee, Wis. Bulletin 1469-C, May, 1933. Style B. Newhouse crusher. Pp. 16.

Rock Drilling. Holman Bros., Ltd., Camborne, England. Bulletin. "The Selection and Care of Drill Steel, Bits, Shanks, and Chucks." Pp. 28.

Steam Stamps. Allis-Chalmers Manufacturing Co., Milwaukee, Wis. Bulletin 1831, Tremain steam-stamp mills. Pp. 4.

Conveyors. Mining Engineering Co., Worcester, England. Bulletin. "Meco" belt conveyors. Pp. 76.

Electric Haulage. Greenwood & Batley, Ltd., Leeds, England. Bulletin. Green-Bat trolley and battery locomotives. Pp. 20.

Roller Bearings. Tyson Roller Bearing Corp., Massillon, Ohio. Anti-friction bearing recommendations and engineering data for application of Tyson cageless tapered roller bearings in mine and quarry cars.

Power Transmission. Falk Corp., Milwaukee, Wis. Bulletin 500. Falk-Rawson four-duty coupling. Pp. 4.

Belt Conveyors. Mavor & Coulson, Ltd., Glasgow, Scotland. Catalog No. 9b. Underground conveyors. Pp. 31. Catalog No. 15. Surface-plant conveyors. Pp. 40.

Drill Sharpeners. Holman Bros., Ltd., Camborne, England. Sheet PT/-487/33. Rotomill, for the hot-milling of rock-drill bits. P. 1.

Daily and Average Monthly Prices of Metals

July, 1933

United States Market

July	Electrolytic Copper: Domestic Refinery	Electrolytic Copper: Export Refinery	Straits Tin New York	Lead: New York	Lead: St. Louis	Zinc St. Louis
1	7.775	7.675	45.250	4.20	4.05	4.500@4.600
3	7.775@8.025	7.850	46.250	4.20	4.05	4.500
4	Holiday	8.075	Holiday	Holiday	Holiday	Holiday
5	7.775@8.275	8.250	47.000	4.30	4.15	4.500@4.600
6	8.275	8.325	46.250	4.30	4.15	4.625
7	8.525@8.775	8.550	48.125	4.40	4.25@4.275	4.750
8	8.775	8.675	47.125	4.40	4.25@4.275	4.750@4.800
10	8.650@8.775	8.775	47.375	4.50	4.35	4.850
11	8.775	8.725	46.375	4.50	4.35	4.850
12	8.775	8.600	47.250	4.50	4.35	4.850
13	8.775	8.750	46.750	4.50	4.35	4.850
14	8.775	8.725	46.700	4.50	4.35	4.850@4.950
15	8.650@8.775	8.750	46.625	4.50	4.35	4.900@5.000
17	8.775	8.750	46.700	4.50	4.35	4.950@5.000
18	8.775	8.725	47.750	4.50	4.35	4.950@5.000
19	8.775	8.725	47.375	4.50	4.35	5.000
20	8.775	8.675	46.000	4.50	4.35	5.000
21	8.650@8.775	8.525	46.000	4.50	4.35	5.000
22	8.775	8.525	46.000	4.50	4.35	5.000
24	8.775	8.350	45.875	4.50	4.35	5.000
25	8.775	8.375	46.500	4.50	4.35	5.000
26	8.775	8.325	45.625	4.50	4.35	5.000
27	8.775	8.225	45.125	4.50	4.35	5.000
28	8.650@8.775	8.225	45.125	4.50	4.35	5.000
29	8.775	8.225	45.000	4.50	4.35	5.000
31	8.775	8.225	44.750	4.50	4.35	5.000
Av. for month	8.635	8.446	46.356	4.452	4.303	4.878
Averages for Week						
5	7.850	7.883	45.700	4.22	4.07	4.515
12	8.660	8.608	47.083	4.433	4.288	4.783
19	8.765	8.738	46.983	4.500	4.350	4.942
26	8.765	8.463	46.000	4.500	4.350	5.000
Calendar Week Averages						
1	7.775	7.642	45.463	4.200	4.050	4.452
8	8.325	8.288	46.950	4.320	4.175	4.640
15	8.754	8.721	46.846	4.500	4.350	4.875
22	8.765	8.654	46.638	4.500	4.350	4.992
29	8.765	8.288	45.542	4.500	4.350	5.000

Silver, Gold, and Sterling Exchange New York and London

July	Sterling Exchange: "Checks"	Sterling Exchange: "90-Day Demand"	Silver: New York	Silver: London	Gold London
1	4.3200	4.3400	36.3750	18.5000	122s 4½d
3	4.4150	4.4300	36.7500	18.5625	123s 1 d
4	Holiday	Holiday	Holiday	18.8750	122s 10d
5	4.5175	4.5375	36.7500	18.9375	123s 7 d
6	4.4700	4.4900	36.3750	18.4375	124s 1 d
7	4.7200	4.7400	36.7500	18.3125	124s 3 d
8	4.6900	4.7000	37.0000	18.0625	124s 5 d
10	4.7950	4.8150	37.2500	17.8750	124s 6 d
11	4.7500	4.7700	37.8750	17.9375	124s 10d
12	4.6750	4.6950	38.2500	18.4375	124s 9 d
13	4.7650	4.7750	40.1250	18.6250	124s 1 d
14	4.7800	4.7950	39.5000	18.6875	124s 2 d
15	4.7775	4.7950	39.6250	18.6875	124s 3 d
17	4.7800	4.8000	39.8750	18.6875	124s 3 d
18	4.8400	4.8550	40.3750	18.7500	124s 5½d
19	4.8350	4.8500	40.1250	18.5625	124s 4 d
20	4.7500	4.7650	38.7500	18.1250	124s 6 d
21	4.6600	4.6775	37.5000	18.1250	124s 1 d
22	4.6200	4.6300	35.5000	17.9375	123s 8 d
24	4.6300	4.6450	37.3750	18.3125	123s 6½d
25	4.6650	4.6850	37.5000	18.0625	123s 6 d
26	4.6100	4.6250	36.7500	17.8750	123s 9½d
27	4.5650	4.5850	37.1250	18.1875	124s 6 d
28	4.5000	4.5150	36.1250	18.3750	124s 8 d
29	4.5200	4.5400	35.5000	18.0000	123s 8 d
31	4.5400	4.5600	35.6250	17.9375	124s
Av. for month	4.64760	.....	37.630	18.341	.....
Averages for Week					
5	4.35400	.....	36.250	.....	.....
12	4.68333	.....	37.250	.....	.....
19	4.79625	.....	39.938	.....	.....
26	4.65583	.....	37.229	.....	.....

Calendar week averages: New York Silver July 1, 35.896; July 8, 36.725; July 15, 38.771; July 22, 38.688; July 29, 36.729.

London Market

July	Copper: Standard Spot	Copper: Standard 3 Mo.	Copper: Electrolytic Bid	Tin: Spot	Tin: 3 Mo.	Lead: Spot	Lead: 3 Mo.	Zinc: Spot	Zinc: 3 Mo.
3.....	37.8750	38.0000	42.0000	223.2500	222.5000	13.3750	13.6875	17.5000	17.5000
4.....	38.2500	38.3750	42.0000	223.7500	223.2500	13.5000	13.8125	17.5000	17.5000
5.....	38.9375	39.0625	42.5000	225.3750	224.7500	13.6875	14.0000	18.0000	17.9375
6.....	38.7500	38.9375	42.5000	223.2500	222.5000	13.7500	14.0000	18.2500	18.0625
7.....	38.6875	38.8125	42.0000	221.5000	221.2500	13.8125	14.0625	18.5000	18.2500
10.....	38.9375	39.0625	42.2500	215.7500	215.7500	13.6250	13.8750	18.5625	18.4375
11.....	37.8125	38.0000	41.7500	211.5000	211.2500	13.3125	13.6250	17.8750	17.8125
12.....	38.5625	38.7500	42.0000	217.7500	217.6250	13.5626	13.8125	18.1875	18.1250
13.....	38.1875	38.3750	41.7500	214.5000	214.5000	13.3125	13.6250	17.9375	18.0000
14.....	38.2500	38.4375	41.5000	214.5000	214.2500	13.2500	13.5000	17.7500	17.7500
17.....	38.0625	38.2500	41.5000	212.6250	212.3750	13.3750	13.6250	17.7500	17.7500
18.....	38.3750	38.5625	41.7500	215.3750	215.2500	13.5000	13.6250	18.0000	18.0000
19.....	38.5625	38.7500	41.5000	216.5000	216.2500	13.6250	13.7500	18.1250	18.1250
20.....	38.2500	38.5000	41.5000	212.7500	212.5000	13.5000	13.6250	17.8125	17.8125
21.....	37.4375	37.5625	41.0000	212.7500	212.7500	13.3750	13.4375	17.6250	17.6250
24.....	36.7500	36.8750	40.5000	213.1250	213.1250	13.0625	13.1875	17.3750	17.3750
25.....	37.1875	37.3125	41.0000	215.7500	215.7500	13.3750	13.5000	17.7500	17.7500
26.....	37.0625	37.1875	41.0000	214.7500	214.7500	13.2500	13.3750	17.3750	17.5000
27.....	36.6875	36.8750	41.0000	214.7500	214.8750	13.1250	13.2500	17.3125	17.4375
28.....	37.0625	37.1875	41.0000	216.0000	216.2500	13.3125	13.4375	17.3750	17.5000
31.....	36.5625	36.7500	41.0000	214.6250	215.3750	12.9375	13.0625	17.1250	17.3125
Av. for month..	37.917	.....	41.571	216.673	.....	13.411	13.613	17.795	17.789

The United States quotations are our appraisal of the major markets for domestic consumption based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices of domestic class are in cents per pound.

Copper, lead and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York is now quoted at 0.35c. per pound above St. Louis, this being the freight differential. Contract prices for High-Grade zinc delivered in the East and Middle West are based on a minimum

Silver and Sterling Exchange

	New York		London Spot		Sterling Exchange	
	1932	1933	1932	1933	1932	1933
January	29.780	25.400	19.623	16.883	342.515	336.060
February	30.136	26.074	19.573	16.885	345.141	342.114
March	29.810	27.928	18.336	17.588	363.463	343.138
April	28.298	30.730	16.923	18.440	374.731	357.565
May	27.755	34.072	16.868	19.046	367.370	393.106
June	27.466	35.663	16.844	19.078	364.471	413.216
July	26.700	37.630	16.930	18.341	354.865	464.760
August	27.986	.....	18.000	.....	347.449	.....
September	27.870	.....	17.998	.....	347.003	.....
October	27.195	.....	17.813	.....	339.500	.....
November	26.698	.....	18.099	.....	327.458	.....
December	25.010	.....	17.110	.....	327.683	.....
Year	27.892	.....	17.843	.....	350.137	.....

New York quotations, cents per ounce troy, 999 fine. London, pence per ounce, sterling silver, 925 fine. Sterling exchange in cents.

Copper

	F.O.B. Refinery			London Spot			
	Electrolytic			Standard		Electrolytic	
	Domestic		Export				
	1932	1933	1933	1932	1933	1932	1933
January	7.060	4.775	4.741	39.459	28.557	46.200	33.244
February	5.965	4.775	4.710	36.917	28.481	41.381	32.556
March	5.763	5.011	4.779	33.039	28.179	36.786	32.370
April	5.565	5.395	5.185	29.943	29.576	34.190	33.681
May	5.237	6.698	6.569	28.548	34.071	32.833	38.163
June	5.145	7.773	7.484	26.872	36.759	30.841	41.000
July	5.053	8.635	8.446	26.071	37.917	29.107	41.571
August	5.219	.....	.....	31.401	.....	34.784	.....
September	5.978	.....	.....	34.986	.....	38.318	.....
October	5.733	.....	.....	31.890	.....	36.190	.....
November	5.131	.....	.....	31.972	.....	36.568	.....
December	4.813	.....	.....	29.088	.....	34.344	.....
Year	5.555	.....	.....	31.682	.....	35.962	.....

New York quotations, cents per pound. London, pounds sterling per long ton.

Lead

	New York		St. Louis		London			
	1932	1933	1932	1933	1932 Spot	1932 3 Mos.	1933 Spot	1933 3 Mos
January	3.750	3.000	3.550	2.875	15.084	15.128	10.458	10.833
February	3.712	3.000	3.499	2.875	14.560	14.571	10.431	10.719
March	3.150	3.146	2.993	3.021	12.345	12.634	10.609	10.821
April	3.000	3.260	2.900	3.135	11.223	11.503	10.872	11.122
May	3.000	3.654	2.900	3.525	10.673	11.036	12.095	12.372
June	2.993	4.173	2.896	4.023	9.608	9.898	13.280	13.571
July	2.747	4.452	2.611	4.303	9.818	10.152	13.411	13.613
August	3.235	.....	3.093	.....	11.349	11.588	.....	.....
September	3.465	.....	3.315	.....	13.122	13.349	.....	.....
October	3.052	.....	2.939	.....	11.958	12.170	.....	.....
November	3.050	.....	2.931	.....	12.071	12.395	.....	.....
December	3.000	.....	2.877	.....	11.144	11.541	.....	.....
Year	3.180	.....	3.042	.....	11.913	12.164	.....	.....

New York and St. Louis quotations, cents per pound. London, pounds sterling per long ton.

Tin

	New York		London	
	1932	1933	1932	1933
	Straits		Standard, Spot	
January	21.804	22.692	140.219	145.708
February	22.018	23.500	139.143	148.544
March	21.863	24.221	129.810	149.120
April	19.244	27.136	108.935	157.944
May	20.948	36.051	122.286	186.207
June	19.659	44.097	114.530	219.964
July	20.931	46.356	125.863	216.673
August	22.985	.....	142.017	.....
September	24.779	.....	152.705	.....
October	23.936	.....	151.280	.....
November	23.354	.....	153.585	.....
December	22.677	.....	149.806	.....
Year	22.017	.....	135.848	.....

New York quotations, cents per pound. London, pounds sterling per long ton.

Zinc

	St. Louis		London			
	1932	1933	1932 Spot	1932 3 Mos.	1933 Spot	1933 3 Mos.
January	3.011	3.018	14.416	14.834	14.381	14.595
February	2.817	2.666	13.872	14.289	13.866	14.119
March	2.787	2.987	12.616	13.024	14.647	14.674
April	2.725	3.298	11.670	11.958	14.951	15.208
May	2.532	3.805	12.432	12.682	15.505	15.660
June	2.777	4.348	11.548	11.866	16.988	16.774
July	2.537	4.878	11.592	11.967	17.795	17.789
August	2.758	.....	13.594	13.844	.....	.....
September	3.322	.....	15.455	15.616	.....	.....
October	3.027	.....	14.869	15.140	.....	.....
November	3.094	.....	15.264	15.534	.....	.....
December	3.124	.....	15.209	15.347	.....	.....
Year	2.876	.....	13.545	13.842	.....	.....

St. Louis quotations, cents per pound. London, pounds sterling per long ton.

Cadmium and Aluminum

	Cadmium		Aluminum	
	1932	1933	1932	1933
January	55.000	55.000	23.300	23.300
February	55.000	55.000	23.300	23.300
March	55.000	55.000	23.300	23.300
April	55.000	55.000	23.300	23.300
May	55.000	55.000	23.300	23.300
June	55.000	55.000	23.300	23.300
July	55.000	55.000	23.300	23.300
August	55.000	.....	23.300	.....
September	55.000	.....	23.300	.....
October	55.000	.....	23.300	.....
November	55.000	.....	23.300	.....
December	55.000	.....	23.300	.....
Year	55.000	.....	23.300	.....

Aluminum in cents per pound, 99 per cent grade.
Cadmium, cents per pound.

Antimony, Quicksilver, and Platinum

	Antimony (a) New York		Quicksilver (b) New York		Platinum (c) New York	
	1932	1933	1932	1933	1932	1933
January	5.976	5.722	64.900	48.500	40.000	26.480
February	6.489	5.738	66.304	48.614	40.000	24.000
March	6.188	5.901	72.537	52.676	40.000	24.667
April	5.746	5.876	72.125	54.580	40.000	26.800
May	5.170	6.264	66.380	56.500	39.500	28.500
June	5.034	6.500	59.481	60.038	37.500	30.000
July	5.000	7.262	53.580	62.900	35.200	32.320
August	5.144	.....	47.444	.....	35.000	.....
September	5.606	.....	47.500	.....	33.800	.....
October	5.575	.....	47.600	.....	33.000	.....
November	5.771	.....	48.750	.....	33.000	.....
December	5.400	.....	48.500	.....	30.462	.....
Year	5.592	.....	57.925	.....	36.455	.....

(a) Antimony quotations in cents per pound, for ordinary brands. (b) Quicksilver in dollars per flask of 76 lb. (c) Platinum in dollars per ounce troy.

Pig Iron

	Bessemer		Basic		No. 2 Foundry	
	1932	1933	1932	1933	1932	1933
January	16.00	14.50	15.00	14.00	15.50	14.50
February	15.68	14.50	14.68	14.00	15.18	14.50
March	15.50	14.50	14.50	14.00	15.00	14.50
April	15.50	14.50	14.50	14.00	15.00	14.50
May	15.50	15.42	14.50	14.42	15.00	14.92
June	14.85	16.00	14.35	15.00	14.75	15.50
July	14.56	16.50	14.00	15.50	14.50	16.00
August	14.50	.....	14.00	.....	14.50	.....
September	14.50	.....	14.00	.....	14.50	.....
October	14.50	.....	14.00	.....	14.50	.....
November	14.50	.....	14.00	.....	14.50	.....
December	14.50	.....	14.00	.....	14.50	.....
Year	15.01	.....	14.29	.....	14.79	.....

Iron in dollars per long ton freight to Pittsburgh, $1.89. F.o.b. Mahoning and Shenango Valley furnaces.

price basis of 4½c. per pound.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

London prices for lead and zinc are the official prices for the morning session of the London Metal Exchange; prices for copper and tin are the official closing buyers' prices. All are in pounds sterling per long ton (2,240 lb.).

New York silver quotations are as reported by Handy & Harman and are in cents per troy ounce of silver, 999 fine. London silver quotations are in pence per troy ounce of bar silver, 925 fine. Sterling prices represent forenoon market demand. Cables command a premium.